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EDUCATIONAL RECONSTRUCTION (2)

Access to the Universities

SECTIONS VIII and IX of the White Paper on Educational Reconstruction deal with access to the universities and the recruitment and training of teachers respectively.

The common thread woven into each of these two sections is insistence on the quality of the human material which is involved. There can be no argument with the statements that "high ability [should not be] handicapped by the accidents of place of residence or lack of means in securing a university education" and that there will be required "a larger number of teachers of the right calibre", and there emerges, perhaps for the first time in proposals for educational legislation, a true and active appreciation of the worth of the job of teachers, and the necessity for a unified scheme for selecting and nurturing men and women for the teaching profession. Tribute is paid in the assertion that "it depends almost entirely upon the quality of those who staff the schools whether the reforms proposed will . . . , in practice, work out as real educational reforms". As we emphasized in the previous article (NATURE, October 9, p. 393), the child must be the true and only centre of education; nevertheless we must see to it that the teacher is trained in the best and fullest manner in order to qualify for the very important tasks before him.

Dangers lie in the administrative problems involved; a mere expansion of the numbers attending universities can be no solution of the problem of quality; machinery must be devised and tested over a period of years to ensure that only those of high ability or of outstanding personality, or a balanced combination of the two, secure places in our universities and university colleges, and that the delightful but uneconomic student who has in the past spent five and even ten years sampling the several faculties of a university (or even several universities) is no longer able to do so. The selection of university men and women is not easy, and it is by no means certain that we have evolved a satisfactory technique in the present scholarship examination system.

Changes are foreshadowed by the recommendations in the Norwood Report, which embody the idea of a school record carrying at least equal weight with formal examination as a test of fitness to profit by university education, and though much experiment will be necessary, there is here the basis for more equitable selection of those who are not academically brilliant, but who possess sterling character and have been brought up in homes where the very fact of being at home has been an education. Such men and women must not be lost to the universities. In the past many of them have not had access to universities because of the financial position of their parents, and might, on a stringent test of academic fitness alone, be ruled out absolutely.

Under the Government scheme of further education and training an influx of men and women whose

further education has been prevented or interrupted by war service will do much for the social and communal life of the universities, which have recently suffered from a reduction in the average age of entry and length of stay of students, with the result that university staffs have rightly complained that many of their students are unable to profit by university methods of teaching, and need more guidance than the already hard-pressed tutor is capable of giving. The White Paper generously looks forward with confidence to the large demands upon the administrative and teaching staffs which will be made by this scheme, and it seems probable that the four-term year which has perforce been instituted in many universities will need to continue, for a time at least, in order to meet the needs of the scheme, even at some sacrifice of the invaluable leisure time which has been lost to war-time students.

Recruitment and Training of Teachers

Greater problems, both legislative and administrative, lie in the proposals for reform in the recruitment and training of teachers. Both recruitment and training are so much and so obviously in need of reform that much has been published on the subject, in almost every type of journal: so much that it can confidently be asserted that the McNair Committee, whose report is awaited with interest, will achieve a miracle if it makes any proposals which can be regarded as original.

The implication that systematic provision should be made for boys and girls to continue their education after senior school age, and afterwards prepare for the teaching profession "if at, say, 15 years of age they express a desire to do so", is dependent for its successful working on a very generous scale of financial assistance, and absolute freedom for the individual to contract out of teaching if he wishes. This means recognition that the training of a teacher up to almost any stage before his active employment in a school is a worth-while investment for the country, even if he never enters the teaching profession, and the complete abandonment of the present system whereby secondary school boys and girls may be tied by agreement to teach after their further education and training at the expense of the State in university or college. Too often the present scheme of Board of Education grants is used as a means to the end of getting a 'college education' for the academically sound student who may be temperamentally quite unsuited to teach, and under whom the next generation of pupils must suffer; nor may the discovery of temperamental unsuitability be made until the fourth year at a university. It is very satisfactory that the White Paper records the fact that "War has revealed that the ability and the character required of teachers is not to be found exclusively in the boys and girls in the grammar schools". Too little respect has been paid to the very great value of the work of men and women in the Armed Forces who have, often for the first time, found themselves called upon to be teachers—teachers not only of matters military but also of current affairs and citizenship, as in the Army Education Directorate's A.B.C.A. and British Way and Purpose schemes—and exemplars of the virtues of courage, constancy and good-fellowship which are none the less virtues of the teacher than of the sailor, the soldier and the airman.

The introduction into the teaching service of men and women who have served in the Forces or in industry will provide a nucleus of teachers who "have had experience of life other than as students and teachers". The narrow circle of school, training college and school must be broken down whatever the cost in administrative labour and cash. In this connexion any plans for a period of public service between leaving school and entering the training colleges or universities will be welcome, as a start in the right direction. Thereafter, exchange between schools, industry and commerce, and public service must be facilitated by every possible means. Great goodwill will be necessary, and recognition by industry, for example, on one hand, that teachers can serve them usefully in employment, and education authorities, on the other hand, that recruits from industry are valuable. Linking the two are those whose talents lie in youth service and adult education respectively.

Much has been done to break down the narrow traditions of the 'two-year' training colleges, which have in the past been responsible for cramping the natural initiative and love of adventure of their students. In this respect the denominational colleges have been the greatest sinners, and in fact are still not free from blame; they have seldom shown the virility of the 'municipal' training colleges. How is it to be ensured that they are more broad in their outlook than heretofore? As mentioned above, a period of public service would do much to ensure that the entrants to such colleges themselves demand a broad and liberal training. The development of the training colleges' association with the universities must provide the basis for a happier state of affairs. Such association already exists in the joint committees of training colleges and universities which are centred in most of the 'provincial' universities. These joint committees, although substantially similar in constitution, having university and training college representatives, vary considerably in their nature, since in certain cases both university and training college representatives are also members of the local education authorities of the area in which university and training colleges are situated. A committee so constituted cannot be expected to favour the full partnership which denominational colleges must be encouraged to enter. It is to be hoped that the McNair Committee will favour the reconstitution of joint committees to include persons of standing, perhaps co-opted, whose main interest is the furtherance of the view that training teachers is *one* problem, and that the university interest is merged with that of the training colleges to the advantage of both. Perhaps the day is not far off when student teachers will receive all their training—academic and professional—within the universities themselves, thus giving them a broader outlook by working in collaboration with students of other callings.

EDUCATION AND RESEARCH IN AERONAUTICS

THERE have been many happenings lately that have tended to focus attention upon the subject of the facilities that should be provided in the post-war future to obtain training for the various branches of the profession of aeronautics. The applied side of this science, the design, construction, and maintenance of both fighting service and civil aircraft and engines, the handling of air transport services, and the host of auxiliaries called into being by these, will need a great deal of pioneer work, based on original thinking, for its organization. The advances in the technical outlook made during this War, together with the problems inseparable from the great increase in the size of the industry, compared with its pre-war dimensions, bring into much prominence the question of training the personnel for the profession.

Many facets of this problem are purely educational and are thus inevitably bound up with the proposals for the reform of the educational system of Great Britain, as foreshadowed by the White Paper on "Educational Reconstruction" presented to Parliament by the President of the Board of Education, and the Norwood Committee's report on "Curriculum and Examinations in Secondary Schools". Following this there are aspects that are general to all those branches of applied science that for convenience can be called engineering. The Institutions of Civil Engineers, Mechanical Engineers, and the Institute of Physics have each issued memoranda upon these. Following this, the particular side of the subject that is aeronautical was the subject of a discussion at meetings of the Royal Aeronautical Society, a report upon which is to be published in due course. The tenth report of the Select Committee on National Expenditure, on aircraft production, also throws valuable light upon the requirements in technical personnel of the aircraft industry as a whole, and comments upon the inadequacy of the supply at present.

The subject of professional education in aeronautics is peculiar in that it is of more recent birth than most of the other professions, and consequently is in a state of immaturity. Most of those intimately connected with it consider that it is suffering from malnutrition, a view supported by the Select Committee's report. The possible remedies are of three kinds. An expansion of the present system, the same expansion with the addition of teaching covering what some consider to be gaps in the existing scheme, or a complete and radical change in the method of approach. Of these the second is the most generally favoured—indeed it appears to be the only one possible. The first is admitted, by experience, to be insufficient, and the last, for fundamental reasons, is impossible in any educational scheme. Within these boundaries there are two outlooks, training in scientific and technical work, and craftsmanship. These two cannot be separated entirely; indeed, it is from the craftsman that some classes of technical men should be recruited.

During the period between the two world wars, steady if not spectacular progress was made in the organizing of training in aeronautics in Great Britain. The many authorities concerned have worked together, and consequently there is functioning to-day a properly co-ordinated scheme that caters for all types of trainees, and is inter-related sufficiently to allow an ambitious candidate to climb the technical ladder to the highest rung if he is mentally capable of doing it. Financially, the position is not yet good. There are a few scholarships devoted specifically to aeronautical training, and many firms in the industry have schemes for helping their apprentices in this respect. The cost of obtaining a part-time training in the technical side of the work, being mostly in the hands of the rate-aided local technical institutions, is not prohibitive to the average apprentice. Under the present war conditions, a small proportion of the State bursaries have been awarded for the study of aeronautical engineering, and the Royal Air Force has a scheme for allowing certain selected technical personnel to study aeronautics, following syllabuses that are of general aeronautical outlook rather than peculiar to Royal Air Force requirements.

The training facilities available in Great Britain at present can be roughly summarized into groups covering the types of trainee envisaged. Repair and maintenance mechanics who are licensed by the Air Ministry, known as 'ground engineers' or 'licensed aircraft engineers', have to pass examinations in certain theoretical aspects of their work. The manufacturing firms, sometimes in conjunction with the local educational authorities, hold classes of this kind. The craftsmen who actually build the firm's products are distinct from these repair men, and do not necessarily hold ground engineer certificates. Their training is of rather a broader outlook and is catered for by the City and Guilds of London Institute (Technological Department), which holds an annual examination called "Aeronautical Engineering Practice". Classes for this are held by the local technical institutions. Apprentices needing a more theoretical training can enter for either national certificates sponsored by the Board of Education and the Institution of Mechanical Engineers, external university degrees, or the associate fellowship of the Royal Aeronautical Society, taking such aeronautical subjects as are available in the curriculum at their teaching institution. Some employers allow their apprentices to undertake some form of sandwich system of training, under which they can give sufficient time to theoretical study in their local institution to be considered as full-time students. They then enter for national diplomas or internal degrees, with similar aeronautical subjects. Some entrants prefer to enter upon a full-time course of study direct from school, and leave their practical training until they have obtained their theoretical qualification. They will take similar courses for either national diplomas or university degrees. There is a certain advantage in this latter system in that if a student finds that he has a flair for the more scientific work, and does not wish to take up the engineering side, he can pass on to study for the higher branches of scientific research without

spending his time in a works. The advisability of ignoring the applied side of any science is open to question, but there may be some aspects of aeronautical science, the more mathematical, for example, where an intimate knowledge of the engineering work is not so important. Lastly, there is postgraduate study available for either of the foregoing men who desire to take up the more scientific work and feel that they would profit by a year or more extra study of the particular aspect of the profession that appeals to them. Such students will probably take up either research or the more responsible posts in design or industrial organization.

This is the programme of training as available at the present time, but there is a school of thought that holds the view that there is one serious gap in this. They consider that advanced postgraduate study at a university is academic in character, and while it is correct for the scientific man and research worker, it is not near enough to the applied side for the industrial entrant. They ask for a postgraduate institution of a more practical character, where much of the teaching would be given by visiting lecturers who are actually practising in their profession, and possibly where flying also could be done at the same time. Such flying would, of course, be looked at from the point of view of being supplementary to the technical training being given, and for the development of the technique of flying and its various auxiliary services, rather than the mere mechanical handling of an aircraft. This view was propounded by Sir B. Melvill Jones at a recent meeting of the Royal Aeronautical Society, and it is understood that it is held by a special panel of the Aeronautical Research Committee which is investigating the question of training in aeronautics for the Government.

The problem that has now to be faced in the world of aeronautical training is two-fold. First, it is necessary to consider the present system, that has been functioning to a gradually increasing extent since 1919, and to use the post-war reconstruction period to correct its shortcomings, if any, at the same time allowing for a substantial increase in the size of the industry as compared with 1938, before the commencement of the present War. Such alterations may be necessary both in size and quality. Secondly, it is necessary to organize the practical side of the industrial training, apprenticeship, etc., in such a way that it accommodates itself both to the new conditions in the general educational scheme, and the improved theoretical aeronautical training facilities that will be available consequent upon this enlargement. There will also be an interim problem of dealing with the younger people who have developed an interest in aeronautics by reason of their war-time work, either in the services or industry, and wish to make it their profession. They will have received a partial training in the practical side of the work—probably a specialized but narrow one due to the war-time necessity of becoming expert in one job only—and will need a rather special training to enlarge this and add the theoretical outlook in as short a time as is reasonable.

To come to concrete proposals, the existing scheme is fundamentally correct, and, possibly with the addition of the proposed more practical postgraduate school, adequately covers the ground. At present it fails to bring forward sufficient trained men only because it is not used to its fullest extent. This failure is difficult to explain, but it is none the less very real. To those working behind the scenes in aeronautics, the fact that there were insufficient well-trained persons coming along has been obvious for many years. The sources of supply can be divided roughly into two parts, the apprentice and the full-time, mostly university, man. The apprentices are taken on in works generally according to numbers agreed upon with the appropriate trades unions, and are presumably sufficient to maintain the supply of new craftsmen. Most of these appear to start on some form of theoretical study under schemes arranged by the employers, but only a woefully small number of them ever reach the stage of taking any of the qualifications that stamp them as being of use for the professional side of aeronautical work. The full-time students' case is different, but the results are equally disappointing. Aeronautics demands fundamental training in the underlying subjects and then adds training in the application of them to its own work. This postulates a longer and more arduous training, which only a few seem to have the ability, enthusiasm, and financial resources to complete. Somehow this source of recruitment to the more technical side of the work must be increased. Fundamentally, the matter would probably settle itself in time if the conditions in the profession were made more attractive; but in the meantime some propaganda would seem to be necessary to rouse sufficient enthusiasm in the minds of the younger men who will be entering their training period in the immediate future. An increase in the number of institutions offering classes in aeronautics would help the general situation, and in this case such educational authorities might be expected to display vision in their programmes, and offer such facilities even though it is not yet established that there exists a local demand for them. Consultations with the local A.T.C. organization might prove a fruitful source of recruitment for the more elementary classes at least.

The failure of so many apprentices to 'stay the course' on the theoretical side indicates that employers might do more to rouse their enthusiasm, and that possibly a certain proportion of the apprenticeships available should be reserved for boys whose school records mark them as being of the more studious type. A proper apprentice supervisor, with the correct outlook and the necessary authority, should be able to watch his charges and possibly allow the more likely ones to give a progressively increasing amount of their time to their technical studies, as they begin to show that they are likely to be of more use in this work than with their hands.

The problem of those returning from the Forces or national service in industry will be as thorny a one as it was after the War of 1914–18, but there is one fact that is outstanding as a result of our experience then. Selection of men to take up the theoretical

side of aeronautics must be made with great discrimination. A mere interest in the subject, by reason of having done war work of a practical nature in it, is not enough. The special knowledge demanded by the aeronautical profession is not easy to assimilate, and if it has to be done in an intensive course, the difficulties will be even greater. A previous interest in aeronautics added to a good wartime record in it is almost a *sine qua non*. School qualifications sufficient to be able to understand the work is necessary, but enthusiasm for the profession of aeronautics is equally essential for the hard task that they are undertaking. The man who merely takes up a university course as a way of obtaining a living for the immediate future will always be a problem to the teaching world. That he should be allowed to fill a place in the scheme for higher training in aeronautics, which will be strained to its utmost limit, is unthinkable.

THE ADVANCED THEORY OF STATISTICS

The Advanced Theory of Statistics
By Maurice G. Kendall. Vol. 1. Pp. xii+457. (London: Charles Griffin and Co., Ltd., 1943.) 42*s*. net.

THIS very handsomely produced volume is one which it will be a pleasure to any mathematical statistician to possess. Mr. Kendall is indeed to be congratulated on the energy and unswerving perseverance needed to complete his heavy task, and encouraged in the still unflagging energy which will be needed for the second volume. So far as he has carried his work, he has certainly done something to sustain the credit of Great Britain in mathematical scholarship.

In his preface, the author explains that his original intention had been to write in co-operation with four other distinguished statisticians. In the event we must congratulate ourselves on the fortunate fact that the intervention of the War compelled him to carry the work out on his own plan, and without the support and encumbrance of such collaboration.

On the many occasions on which I have been consulted as to the feasibility and desirability of a large-scale work on mathematical statistics, I have pointed to the discouraging circumstance that the advances of recent decades had been so subversive, not only to the methods but also to the points of view from which statistical problems are approached, that any presentation containing material expected by, and acceptable to, the leading minds of an earlier generation would come soon to be recognized as pointless and obsolete. Mr. Kendall deals tactfully with this difficulty, though without altogether solving it. Thus at first sight his contents pay at least formal respect to the old convention of expounding statistical methods under the headings, measures of central tendency, measures of dispersion, and finally, crowning the arch, measures of correlation. The last four of the sixteen chapters in this volume are indeed given up to various coefficients of correlation and association, not, it is true, quite in the old style, for the subjects are treated with a mathematical competence, based on a wide familiarity with the literature, far beyond anything previously attempted, but one is tempted to say also, beyond the intrinsic interest or practical utility of the methods under discussion. Why should anyone now wish to calculate a rank correlation, or a coefficient of contingency?

The modern reader, on the other hand, would like to see a much fuller development of Chapter 10, on exact sampling distributions, and a far wider and more varied exposition of the uses of the χ^2 distribution than is supplied in Chapter 12. In the case of both these chapters, the subjects of which are of the greatest importance to the statistical reader, the approach is barred by an opening section of quite unnecessarily complex algebra. The perfunctory treatment of χ^2 suggests that Mr. Kendall is not immune from the weakness of other heavily burdened authors to scamp those portions of the work in which they are not particularly interested.

The same perfunctory attitude emerges on p. 59 in a short section devoted to the calculation of factorial moments by successive summation. The author says: "The use of the method in practice lies in the fact that for certain calculating machines the progressive summation is easier to carry out than the processes involved in the method of Example 3.1".

From one very highly equipped machinist to another, this may be true enough, though surely an understatement, for a method which replaces a large number of multiplications by an equal number of additions. The saving of labour is evidently most important when no machine is used at all, a condition in which even the most perfectly equipped among us must occasionally work. The method also of abbreviating the process further by summing from both ends to a chosen origin is not given, so that, unless he has independent information, the reader is not in a position to judge how valuable the procedure really is.

The presentation of purely mathematical points is, generally speaking, careful, although, as has already been suggested, cumbrous proofs are sometimes used just where, for the general usefulness of the book, they should have been avoided. Two small points and one of greater importance are perhaps worthy of the author's attention with a view to subsequent editions.

To say, as on p. 53, that "The moment about the mean of order $2r$, if it exists, is given by" a certain expression is not logically the same as to say that it is defined by the expression, and therefore exists, if the expression has a meaning. Kendall's form of statement suggests, contrary I suppose to his intention, that there is some other condition necessary for the existence of the moment.

In examples 3.7 (p. 59) and 3.8 (p. 66) the symbols μ and κ appropriate to the population are applied to statistics derived from a sample. It is true that the sample is large, giving the heights of more than eight thousand men, and therefore the errors of random sampling will be comparatively small, but it is none the less a pity to confuse the student at this stage by blurring a distinction which will later require his full attention. The other examples, 3.9–3.11, are properly applied to distributions.

Mr. Kendall is much interested in the rather formidable algebra of the symmetric functions used in mathematical statistics. Thus the formulæ for translating moments into cumulants and *vice versa* are set out in full to the tenth degree on pp. 61–64, and in other parts of the book a good deal of space is given to proofs establishing similar relationships. In my own experience the approach to all work of this kind is greatly eased for the majority of mathe-

matical statisticians by a preliminary consideration of the nature of partitions, and an introduction to the appropriate terminology and notation. Whereas, however, in Chapter 3, on moments and cumulants, mention of partitions seems to be carefully avoided, the reader of Chapter 11, in which more comprehensive methods of analysis are developed, is confronted without warning or preparation with the notions (*a*) of partitions, (*b*) of partitions of multipartite numbers, and (*c*) of separations of partitions, as ideas which are essential to each difficult stage of the argument. The fact is that some mathematical statisticians have thought about partitions and in terms of partitional notation, while others have not done so at all. These are not going to be helped, but only baffled by the manner in which the ideas are here introduced.

Each chapter is followed by a series of exercises, some of which are exceedingly good. Some examples in the text are at least equally difficult to the reader anxious to understand the solution. Thus in example 7.2, the following argument is used to demonstrate the recurrence formula, which yields very prettily the series of sub-factorials developed by Euler for the problem of the game of *Rencontre*: "Suppose that u_n is the number of ways in which all the letters go wrong. Consider any two letters. If these occupy each other's envelopes, the number of ways in which the remaining $n-2$ letters can go wrong is u_{n-2}; and there are $(n-1)$ ways in which two letters can be interchanged. But if one letter occupies another's place and not vice versa, which can happen in $(n-1)$ ways, there are u_{n-1} ways in which the others can go wrong". I have not made the test widely, but I submit that very few mathematicians unfamiliar with this particular argument would be able from this form of statement to see where the two factors $(n-1)$ really come from. R. A. FISHER.

ORE DEPOSITS

Ore Deposits as related to Structural Features

Prepared under the direction of the Committee on Processes of Ore Deposition of the Division of Geology and Geography of the National Research Council, Washington, D.C. Edited by W. H. Newhouse. Pp. xi+280. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1942.) 44*s*. net.

THE study of the genesis of ore deposits does not appeal to geologists in Great Britain (with a few notable exceptions) to anything like the same extent it does in the United States and Canada. In America a great and growing number of men have adopted economic geology applied to mining as a profession, and interesting contributions to the science regularly appear in the scientific and technical press. The reason may be due to greater interest shown in mining ventures by people in America, or may result from greater opportunities for practising the profession provided by the many diverse types of deposits found there.

In any event, the rapid expansion of the non-ferrous mining industry in the United States has stimulated the scientific study of the deposits themselves. In a few outstanding cases, such as manganese in the Gold Coast and coal in Kent, the geologist either actually discovered or predicted the presence of the mineral, but in the majority of instances 'finds' by prospectors have created the need for geological specialists to interpret the discoveries.

Some decades ago, geologists in Great Britain paid more attention to the problems of the metal-mining engineer, but with the decline of non-ferrous metalliferous mining the interest of the majority waned. This is unfortunate because, while it is true that most of the easily accessible deposits have been worked out, there exist several areas which, if thoroughly explored, might again yield discoveries which could be worked successfully in spite of world competition.

This book, which is published by the Princeton University Press and prepared under the direction of the Committee on Processes of Ore Deposition of the Division of Geology and Geography of the National Research Council, Washington, and is edited by Prof. W. H. Newhouse of the Massachusetts Institute of Technology, can be divided into two parts. The first portion consists of a general discussion on the controlling effects of structural features on the deposition of various ores, while the second and major part contains short discussions by some sixty different contributors on particular ore deposits to illustrate the diverse effects of various geological features. The studies do not enable any hard and fast rules or laws to be promulgated, but the deposits do fall within a broad classification.

Mining geology is not yet, and probably never will be, an exact science, because there are too many exceptions to general rules; but a careful study of this work will afford guidance to many a geologist when confronted with a difficult problem concerning a particular deposit, and it is therefore recommended as a valuable book of reference which should be included in every library of scientific books.

The book is very well illustrated and the print easy to read, but it is too bulky to form part of a field library. As is only to be expected with a volume containing contributions by so many American writers, the ordinary reader who has been so unfortunate as not to have received some of his training in America will find difficulty in translating some of the scientific or technical terms used into those with which he is more familiar. J. A. S. RITSON.

DEMONSTRATION-LECTURES IN PHYSICS

Analytical Experimental Physics

By Prof. Harvey Brace Lemon and Prof. Michael Ference, Jr. Pp. xvi+584. (Chicago: University of Chicago Press; London: Cambridge University Press, 1943.)

THE purpose of this book, as stated in the preface, is to provide a record of demonstration-lectures which were given to second-year students attending a general course of physical sciences at the University of Chicago. Will it fit any British syllabus? A comparison with those of the University of London will be a stage towards deciding this question. The book contains what is needed for London Intermediate Science, and much more besides. Of the twenty questions set in the London External General B.Sc. in June 1938, seven can be answered fully with the aid of this book, seven partly; and on the remaining six it gives no guidance. The deficiencies, for this purpose, are mostly that useful general notions are not developed in sufficient quantitative detail. For examples: (i) pairs of separated thin

lenses are treated, but not by the method of principal points; (ii) the potential energy of an electrostatic system is worked out for two conductors, but not for many; (iii) a formula for the bending of a beam is stated without proof; (iv) it is assumed that the gravitational attraction of the earth for all bodies near or far acts as if the mass of the earth were all concentrated at its centre. Electromagnetic waves receive scant attention. Yet in other directions the book goes far, treating, for example, the gyroscope, the mass-spectrograph, the three-colour analysis of vision, and the triode-amplifier; but not the triode-generator. The reviewer is left wondering to what extent syllabuses in Britain and the United States are determined by scientific or social necessity, and to what extent by academic habit.

The outstanding merit of the book resides in its illustrations. There are 584 line diagrams in the text. In addition, there are 64 pages, called plates, showing photographs accompanied by descriptions. Many of these photographs are taken from cinematograph records so as to exhibit the successive phases of lecture-experiments. From these sequences the student can obtain a much more vivid impression of what actually occurred than he could from a single line diagram; but, to gain this advantage, he will probably have to make an extra effort; for the photographs inevitably show many features that are not essential to the principle of the experiment and which must be sorted out mentally. Also some essential marks are almost, or quite, invisible in the print, notably the clock-hand in several dynamical experiments. Perhaps a bright hand on a black face would have photographed better. The defect is, however, repaired by printing the clock-readings. Many of the plates are superb.

The text flows along interestingly. The discoverers, of many nationalities, are mentioned with their dates, and with allusion to the more important controversies. There are exercises for the student both in calculation and in thinking out what would happen if the experimental conditions were varied. Thus the book affords that training in method and criticism the absence of which was lamented in a recent review ("Shortened Physics", NATURE, July 3, p. 7). But, with these merits, the work of Lemon and Ference could not be short. It weighs 2·3 kgm.; and inquiry of the English publishers elicits a provisional price of 42*s*.

The descriptive text is interspersed with mathematical proofs of the usual kind, employing the calculus sparingly. There is an appendix of 16 pages on pure mathematics, partly an explanation, partly a summary of useful but unproved formulæ.

There is an unfortunate muddle about the paraboloidal mirror. If we ignore diffraction, then all the rays from an infinitely distant point which are reflected by the mirror meet again in a common point-image, provided the object-point lies on the axis of the paraboloid, but not otherwise. As the object moves off the axis its image becomes increasingly blurred. Lemon and Ference call the image "aplanatic" (p. 482). But that is contrary to the usage of Abbe, who discovered the sine condition for aplanaticism, by which he meant the sharpness of the image both on and off the axis.

Detailed criticism must not hinder the recognition of the general excellence of this book by Profs. Lemon and Ference. It will be of particular value to any students who are unable to attend demonstration-lectures.

LEWIS F. RICHARDSON.

PETROLOGY OF IGNEOUS ROCKS

Eruptive Rocks

Their Genesis, Composition, Classification and their relation to Ore-Deposits; with a Chapter on Meteorites. By Dr. S. James Shand. Revised second edition. Pp. xvi+444+3 plates. (London: Thomas Murby and Co. Ltd.; New York: John Wiley and Sons, Inc., 1943.) 25*s*. net.

THIS second edition of Prof. Shand's valuable text-book has been fully revised, partly rewritten and rearranged, and enlarged by 84 pages. The sequence of chapters is much the same as in the first edition, although their contents have been to some extent redistributed, but new chapters on the order of crystallization, compatible and incompatible phases, and eruptive rock complexes, have been inserted into the petrological part of the book. The chapter on eruptive ore deposits which formed part of the first edition has been omitted.

The result of this revision and rearrangement is that what was originally a good account of the physical chemistry and origin of igneous rocks is now perhaps the best in print. However, in the chapter on temperature and pressure in the magma, there seems to be some confusion between magmatic reservoir temperatures and temperatures of intrusion or extrusion. The conclusion on magmatic temperature (p. 69), that there is no evidence that any body of deep magma ever had a temperature higher than 1170° C., and that, in many cases, the temperature may not have exceeded 870° C., may be correct in regard to intrusion or extrusion temperatures. But in view of H. H. Thomas's work on the xenoliths occurring in basaltic sills of the Loch Scridain district (Mull), the new minerals in which imply reservoir temperatures of between 1400° C. and 1250° C. *before* intrusion, the above conclusions cannot be maintained with regard to reservoir temperatures.

Prof. Shand's powerful strictures on the Rosenbuschian order of crystallization, and on the vague uses of the ill-defined term "magmatic differentiation", will now probably be subscribed to by the majority of petrographers.

The second half of the book deals with classification, nomenclature, and description, and in this Prof. Shand excels. Something might be said in criticism of the mode of classification, which is based, as the author says, on antipathies rather than affinities between the igneous rocks, but much more space than is here available would be needed for its adequate discussion. The classification is simple, easily understandable, easily applied, economical of names, and will thus appeal strongly to the student. Researchers, however, will turn with grateful enthusiasm to the wealth of excellent digests of recent work on igneous petrography, which are drawn from the petrographical literature of the whole world, not even excluding the Soviet Union.

The book is clearly and simply written with many exciting passages in Prof. Shand's well-known pungent, not to say pugnacious, style. The chapters are headed by apposite quotations which testify to his wide humanistic reading, and end with well-selected and unhackneyed lists of literature. Although it does not consider some important aspects of igneous rocks as, for example, their distributional and tectonic relationships, the book is, in the reviewer's opinion, by far the most complete and satisfying text now available to put into the hands of the advanced student of the subject.

G. W. TYRRELL.

TIME PERSPECTIVES IN SCIENCE*

By PROF. A. E. HEATH
University College, Swansea

ONE of the best ways of broadening our minds, and clearing ourselves of local limitations and prejudices, is travel in space. Travel in time is equally effective, and cheaper. It takes us out of our narrow setting and restores our sense of proportion by confronting our parochialisms with those of other peoples and periods.

This is true in science as in other human concerns. Here, too, are fashions and unconscious temporal shortsightedness. Even inside the special sciences themselves, historical considerations are important. Although "any science which hesitates to forget its history is lost", it can equally be asserted that any science which does not relate itself to its historical background runs the risk of sterility. Its origins, as specialization increases, may be lost sight of; and dead ends appear in developing thought as in the evolution of living creatures. Its connexions with cognate studies tend to be overlooked, and fruitful possibilities of investigation, produced by a sort of cross-fertilization, neglected. The very meaning of its terms may be too narrowly conceived, as Huxley hinted when he said, "The parallax of time helps us to the true position of scientific conceptions as the parallax of space to that of a star".

It is, however, when we think of science as an instrument for furthering human ends that the full importance of its history comes to light. Viewed in its wider setting, we can see that man has, now, accumulated more knowledge than he can apply. This is sometimes spoken of as a failure in moral insight. If that were the correct diagnosis it would be a very curious thing, considering the many centuries of concentration by saints and sages on moral issues. I prefer to put the emphasis elsewhere. I should call it a failure of nerve. Wisdom is not knowledge only, but knowledge plus plasticity. We lose our nerve when we fail to adapt ourselves to change.

It is not commonly realized how modern the modern temper is. By applying a balanced form of reflexion (in which a passion for brute fact is combined with capacity for generalization) to every department of human life, we have achieved, in the last three centuries, a picture of the world which is staggeringly different from those cosmologies within the framework of which our institutions have been built. The step from Dante's world to that of Einstein and Freud has been taken much too briskly for us to keep pace. The new world is just as wonderful as the old, providing the fullest scope for philosopher, poet and prophet to work their synthesizing genius upon. But this enterprise has scarcely yet begun. We have been too much occupied with piecemeal adjustments to the disturbing political and economic developments which have followed on the heels of intellectual change. Consequently we have been forced to carry over our old mental furniture (to amplify an image of the late J. W. N. Sullivan's) into new settings for which it is ill-suited. Our first dwelling, at the beginning of this period of three hundred years, was the neat, cosy, friendly world of Dante in which we could live confidently, regarding Nature as subservient to our human purposes and destiny. From that we passed on to the wider world, big and orderly but detached, of the Newtonian system; and now, in our own day, we are translated to a vast, though bounded, universe—so bare and empty that the mind reels at its immensities and cold unconcern. Throughout all these changes we have carried with us the same homely mental furniture that served us in our first dwelling-place. It is as though we began by making shift with the contents of a small cottage when we moved into a lordly mansion in Park Lane. That would be bad enough. But the further move is like transplanting our little belongings to the middle of Salisbury Plain.

It is hard enough for us to readjust our attitude to the world outside us—to the macrocosm: but when we turn our attention inwards to the microcosm, to the little world of man and his social relationships, the difficulties increase enormously. For in this realm, too, we are carrying into the new era, with even greater tenacity, mental presuppositions about all sorts of things—about nationality, about economic realities, about sex and family—which served us in the past but may now, in altered conditions, bring ruin upon us. It is not a question of destroying our mental furniture: we cannot hope to start afresh with new minds and bodies. Our problem is, rather, how best to reshape and supplement what we already have. But before such refashioning can be begun, we have to rid ourselves of the superstitious terrors which now hinder us, in every department of social affairs, from organizing our civilization so as best to

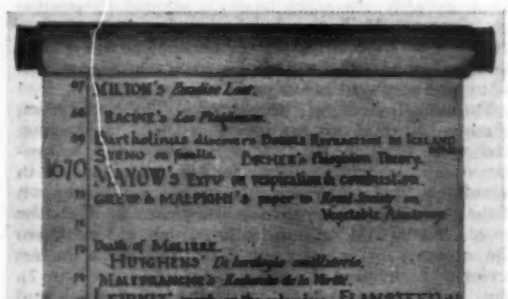


Fig. 1.

* Substance of a lecture at the British Social Hygiene Council Summer School at Eton College, August 1943.

serve the ends of human happiness. Scientific knowledge does not of itself free us. "Learning", as Santayana has remarked, "does not liberate men from superstition when their souls are cowed and perplexed". To the bread of knowledge must be added the salt of intelligence—by which I mean the power of plastic adjustment to change. That is the touchstone by which the future of man on this planet can be gauged, as it has been the test for every other animal throughout geological time: Can he adapt himself quickly enough to changes in his environing conditions?

Our social and cultural disharmonies are thus largely the product of our failing to acclimatize ourselves to modern cosmologies. There is a disastrous divorce between what we know and what we feel: and to this our nerveless grasp upon our destiny is due. The prime essential for adaptation is a synthesis of the sciences of life with the sciences of the physical world. We shall need to fit our studies into a wider and more inclusive perspective. If we are to have a technocratic order it must transcend its engineering stage and become a biotechnocracy.

In the achievement of this, historical considerations are paramount, and they need not be complicated. We have the knowledge. It only needs to be effectively geared. Even such ordinary things as chronological charts provide admirable means of travel through time. These have two useful qualities. They help us, in the first place, to grasp the connexion between events in a given period; and in the second place, to set the period itself in its proper time-relation to others.

As an example of the first, there is reproduced in Fig. 1 a small portion of a long chronological chart I made partly for my own amusement and partly because I wanted to get an idea of the historical background of scientific work in different ages. I therefore put down the names of men of science and their discoveries, varying the size of the lettering with the importance of the man or his work, in red script: and then entered on the chart, in black, events in social and cultural history. I was astonished to find how illuminating a bare chronological series of events, set out in this way on a uniform time-scale, could be. In the portion of the chart here illustrated it is possible, for example, to see at a glance that the seventeenth century was not merely the age of mechanics in its narrow sense; that characteristic is reflected also in other branches of human activity. Besides the names of Newton and Leibniz we see that of Borelli, whose book "De Motu Animalium" is the first application of mechanical ideas to the structure of the human body; of Spinoza, whose "Ethics" was written, under the influence of the prevailing mood of the time, in "a geometrical manner"; of Scarlatti, who did not scorn technical experiment as a basis for composition. The whole thing hangs together.

The complete chart, upon which the sixteenth century is also entered, is several yards long, and can be moved on its rollers so that it can be looked over in a few minutes. History unrolled in this manner, by the yard, enables us to catch other unities. It becomes clear, for example, that each age has its own peculiar scientific flavour. Thus there is a certain disconnectedness in the scientific entries in the sixteenth century: it was more like the spasmodic inventiveness which still stands for 'science' in many minds. When we turn to the seventeenth century, we notice at once instances of inter-

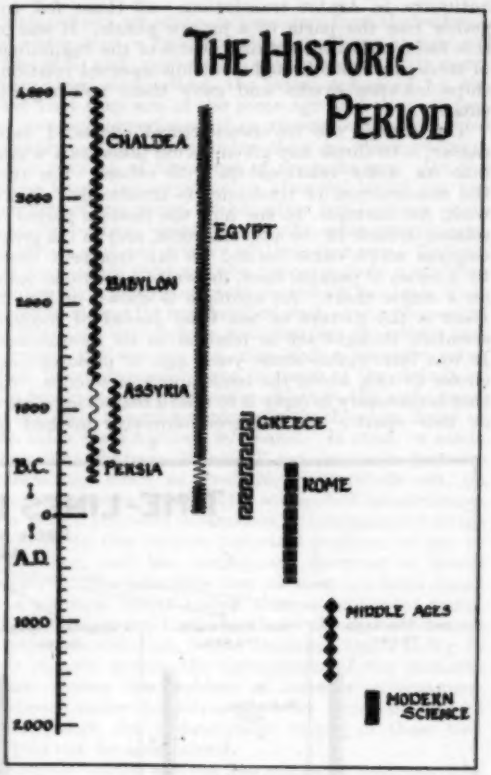


Fig. 2.

connexion and co-operation. Results in one field were used in another—as when Galileo, hearing of the invention of the telescope, constructed one, but turned it immediately to astronomical use; or when Pascal tried the effect of carrying the Torricellian tube up a mountain to see if the lessened weight of the atmosphere would be registered. The increasingly co-operative and cumulative character of science in the seventeenth century was brought out also by the appearance on the chart of the date of foundation of all the great European academies of science. This characteristic makes one realize, as nothing else can, the importance of this century for future ages; since without it the ground could not have been cleared of the age-long accumulation of systems which cumbered it. Individual men working in isolation could not have coped with the enormous labour of putting such systems to the test of fact.

Another way in which the mere setting of events in order provided illumination was in the chart of the same kind which I made for the Middle Ages, and from which it became clear that the only scientific work in the earlier centuries of this period was under Arabic names. My own school-history had given me no hint of the fact that for several centuries the torch of Western civilization was in Mohammedan hands. Here, suddenly, I was brought face to face with it. The scraps of knowledge I possessed about the beautiful, but mysteriously early, Moorish architecture in Spain; about Toledo steel; about the Arabic origin of words like alchemy and algebra; about the sources of our knowledge of classical

antiquity in Arabic translations—all these fell together like the parts of a jig-saw puzzle. It was in this fashion that the detailed charts of the beginnings of modern science brought out unsuspected relationships between events and gave them new significance.

The second use of chronological charts, I said earlier, is to throw any given period taken as a whole into its wider relationships with others. For this the construction of time-lines is invaluable. If we wish, for example, to see how the modern period is related in time to the ancient world, and to the great empires which came before, we can represent them by a series of parallel lines, drawn to a common scale on a single chart. An example is shown in Fig. 2. Here is the picture of the brief period of modern scientific thought set in relation to its forerunners. It was fashionable some years ago in philosophical circles to talk about the bankruptcy of science. All that is necessary in reply is to take a reassuring glance at this chart; the balanced objective method of viewed as biological processes: not like the mechanical changing of the harness of a horse, but more like a reptile shedding its skin: a delicate business, not lightly undertaken. A new biotechnology, in making this explicit, will help to free us from the exaggerated fears which tempt us to purchase security at the price of servitude.

Even broader relationships of our modern period to earlier ages can be illustrated if we extend the range of our charts by making the scale successively smaller, a method used with great effect by Olaf Stapledon in one of his books. A series of time-lines constructed in this way is shown in Fig. 3. In the first of these, in which each unit of length represents a thousand years, we see the whole historical period dwarfed to insignificance in comparison with the range of man's neolithic civilization. In No. 2, where each unit is ten thousand years, this in turn is dwarfed by the vast length of the palæolithic or old stone age of man, before he had created anything but the crudest of stone weapons or developed an

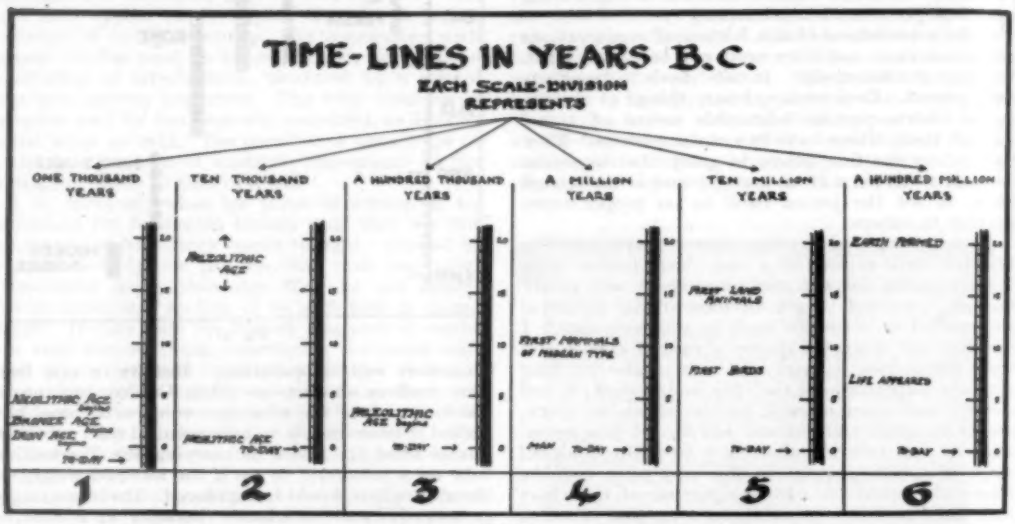


Fig. 3.

reflexion which we call science is too recent an acquisition for us to pass final judgment on it. It is interesting to notice, on this chart, the comparatively great length of line representing the stable early empires. It reminds us of the important fact that man has been able to build for himself solid, and even partially urban (though unprogressive), civilizations, on the basis of a rigid fibre of law—unchanging as the laws of the Medes and Persians—in which the subordination of the individual to society is far greater than in our time. Perhaps man was more docile in earlier ages, before his reflective awakening to complete social self-consciousness in ancient Greece. In our day we are forced to stress the character of *change*, because we live in a time of change and have much leeway to make up. But we must never forget that there have been many civilizations before our own; and that some of these, as in China and the East, can reach a high cultural level of an unchanging kind if they are content to remain mainly agricultural. For living renewal, cultural changes are necessary: but they must be agricultural society. The palæolithic period indeed runs over to No. 3. We are thus enabled to comprehend the vitally important time-relation between man's hunting, agricultural and modern forms of social organization. It probably took him a quarter of a million years to create a society out of the hunting pack; and some five thousand years more to produce an ordered agricultural community. Building on his newly acquired powers over natural forces it should, Prof. J. B. S. Haldane has not too hopefully suggested, take him a shorter time to evolve a stable industrial society. Perhaps we shall be more hopeful if we remind ourselves how brief, in comparison with his whole life, is the modern period. If, now, we extend our scales still further we have on No. 4 the appearance of mammals of modern type; on No. 5 birds and the first land animals; and on No. 6 there comes at last into our ken the beginning of the earth itself.

But the beginnings of things remind us inevitably of ends. Our imagination, once started, may range forward into the far distant future: and we may pass beyond these discussions of the immediate problems

of human civilization to wonder about their ultimate end in the death of the solar system.

We have been looking at man in the light of time. It may be felt that the tale is incomplete unless we also try, with Spinoza, to view him "in the light of eternity". Many will be able to face this last ordeal hopefully because they are convinced that, whatever may be the final fate of our world, there is an eternal place for man in the universe. I myself have no such conviction. Yet I do not despair—as some unhappy folk do, who have not the support of faith. To them I would offer the consolation of another journey through time under the guidance of Sir James Jeans. Imagine a clock which ticks not seconds but years. Its minutes will be a man's three score years. By this clock it was only seventy years ago that the earth was formed; only three days since man appeared; and only five minutes from the beginnings of balanced reflection. *On this scale* the astronomer gives man, at a very low estimate, another seventy years to run his course upon this planet. Mankind is thus, by this reckoning, a three-days old baby, born into a house seventy years old. He has only in the last few minutes woken up to a first awareness of his surroundings, and has the prospect of seventy years of life before him. There are moments in the lives of men, even of young men, when they fret at the passing of time. Like the Shropshire Lad contemplating the loveliness of cherry-blossom in spring, they murmur regretfully: "Of my three score years and ten, Twenty will not come again". But it is only a passing mood at twenty. It should not be a mood at all for the new-born infant.

There is another lesson to be learned from this way of viewing the human race in time. The baby is not likely to be concerned at the briefness of its life: but it is, so modern psychologists tell us, likely to be longing inarticulately for a return to the simpler conditions of dependence which it enjoyed before birth. That mood, so beautifully expressed in another of A. E. Housman's poems beginning, "Be still my soul, be still; the arms you bear are brittle", can carry forward into later life. Our infantilisms in social affairs bear witness to this. The danger which faces the human race in its present infant form is not hopelessness at the prospect of ultimate extinction, but despair at the harsh complexities of life which it is being forced to face. The real choice before us is between despairing refusal to grow up and its only alternative—resolute advance to maturity along the path of clear-eyed reflection.

STUDIES OF TWINS IN THE SOCIAL SCIENCES

By JOAN C. SQUIRES

TWINS, together with other multiple human births, have always been of interest to the society of which they are members. In primitive communities, twins are regarded as being possessed of supernatural powers, which may or may not prove propitious to the group. Within the last seventy years, social scientists have made use of twins in an effort to solve the vexed question of the respective influences of heredity and environment on the formation of human character and physique.

There are two distinct types of twins. Dizygotic or fraternal twins are the product of two separately fertilized ova, which are independent from the moment of conception. Twins of this type have a common pre-natal and post-natal environment, but apart from these similarities, the latter enhanced by the fact that they are of the same age and thus subject to common experience, they appear to bear no more resemblance to one another than to other siblings. They may be of the same or opposite sex. On the other hand, monozygotic or identical twins are the product of one ovum, which, after fertilization, splits into two—these twins possess the same genetic constitution and are always of the same sex. Criteria for diagnosing monozygotic twins include a striking similarity in general appearance, which results in their being mistaken for one another, such as the possession of identical hair colour and texture, eye colour and pigment pattern on the iris—and a stronger cross than internal resemblance in most of the details of the finger and palm patterns—that is, the right hand of one twin resembles more closely the right hand of the other than his own left hand. It must be made clear that the term 'identical' can, in one respect, be misleading, since, as Prof. Newman points out, no two persons are born exactly alike—but he attributes the slight physical differences of monozygotic twins at birth to the inferior pre-natal position of one to the other, and the consequent decrease in blood supply[1]. The principle that all men are born equal is a political belief rather than a biological truth. The fact, however, that identical twins have the same genetic constitution, while fraternal twins differ in this respect within the limitations of the parental genes, makes the problem of heredity-environment influence easier to solve, since by series of control experiments the approximate values of these two factors can be ascertained.

Francis Galton was the first person to make a study of this problem. He examined thirty-five pairs of similar and twenty pairs of dissimilar twins, with the object of determining whether or not similar twins became unlike as a result of difference in environment, and whether dissimilar twins became more alike when living in the same environment. The segregation into similar and dissimilar was not as scientific as it would be were the experiment carried out to-day, but it approximated roughly to a division between identical and fraternal twins. Galton relied for his evidence on reports of the twins made by near relations or friends. These anecdotal sources of information have now been rejected in favour of control experiments. He was concerned more with a study of the physical than the mental characteristics. Both members of seven pairs of similar twins suffered from the same physical ailment, and there were two cases of similar insanity. Eleven pairs reported similarity in association of ideas—for example, one twin would begin a sentence and the other would end it. In nineteen cases of similar twins, however, there were marked differences in disposition, but these were ultimately attributable to illness or accident. This led Galton to the conclusion that: "we may, therefore, broadly conclude that the only circumstances within the range of those by which persons of similar conditions of life are affected, that is, capable of producing a marked effect on the character of adults, is illness or some accident which causes physical infirmity. The impression that all this leaves on the mind is one of some wonder whether nurture can do anything at all beyond give instruction in professional training. There is no escape from the conclusion that nature prevails enormously over

nurture, when the differences of nurture do not exceed what is commonly to be found among persons of the same rank of society and in the same country."[2]

Galton's conclusions formed the basis of the heredity school of thought, whose views were accepted without question for some years. At the beginning of this century, however, men of science began to resume experiments with twins to test the validity of Galton's arguments. The first study of twins to make use of tests was that of Thorndike in 1905[3]. Thorndike wished to discover whether twins are more alike in abilities subject to training than in those not subject to training. With this purpose in mind he constructed tests which would measure educational achievement and those which would measure mental ability, unaffected by training, from the fact that there was no higher correlation between the attainment of twins in the educational achievement tests than in those measuring purely mental ability. Thorndike deduced that the similarity of twins was inherited rather than acquired, particularly as the correlations between twins of an older age were slightly less than those of younger twins. In this experiment there was no attempt made to distinguish between identical and fraternal twins.

Modern intelligence tests were first used with twins by Merriman in 1924[4]. He divided the twins into two age-groups—the 5–9 years old and the 10–16 years old. His results concerning the resemblance at a younger and older age tallied with those of Thorndike. He found, also, a higher correlation between twins of like sex. As one of the criteria for diagnosing monozygotic twins is that they are always of the same sex, this confirmed the fact that identical are more alike than fraternal twins. Having studied the handwriting of twins and found it not very similar, he put forward the suggestion that the similarity in growth and structure, which is found to obtain between many pairs of twins, may not necessarily extend to the finer organization of the nervous system.

Intelligence testing of twins has led to interesting results. Merriman discovered that twenty-five out of sixty-seven pairs of like-sex twins had identical intelligence quotients, and that the measurements of siblings resembled those of fraternal rather than of identical twins. Wingfield discovered that the intelligence quotient correlation between identical twins was 0·90, while that between fraternal twins was 0·70. Working with forty-two pairs of monozygotic and fifty-seven pairs of dizygotic twins, his results showed that the intelligence quotient correlation between the former was almost twice as great as that of the latter. His conclusions state, among other things, that differences in intelligence are closely related with differences in relationship, and are doubtless due to hereditary differences, but this does not mean that the intelligence quotient is not modifiable by training[5]. Hogben, who conducted experiments along the same line, discovered that the mean difference in intelligence quotient between identical twins was 9·2, while the difference in the case of fraternal was 17·8. He also made the interesting discovery that on re-testing, an identical twin resembles his co-twin more than himself, as shown by the previous test[6]. Identical heredity does not abolish intellectual differences, but it does reduce them to negligible proportions. Research in this direction has proved the idea that twins are sub-normal to be a fallacy. A person suffers from no intellectual handicap by being one of a pair of twins.

Rosanoff studied more than a thousand pairs of twins, in which one or both exhibited some kind of mental disorder, and his conclusions are of interest[7]. Reports showed that only about half the cases of mental deficiency were hereditary—the others were due to infantile diseases or birth injuries. Hereditary factors play a more prominent part in simple uncomplicated cases of mental disorder than in those associated with infantile palsy, epilepsy, behaviour difficulties and juvenile delinquency. They are also more important in the more extreme grades of mental deficiency, such as imbecility and idiocy, than in those grades commonly described as 'dull' or 'slightly subnormal'. Birth injuries are responsible for a large proportion of the latter class. Mental deficiency is more common in identical than fraternal twins, in males than in females, and in the first-born than the second-born twin. These conclusions showed that geneticists are faced with great difficulties when interpreting the pedigrees of families in which feeble-mindedness is prevalent, since, as it has been shown, not all cases of mental deficiency are hereditary.

In the United States, a study of twins has recently been completed by a statistician, a psychologist, and a research worker specializing in the biology of twins[8]. The general purpose of the study was to discover the extent to which the characteristics of human beings, especially ability and behaviour, are determined by their genetic constitution, and the extent to which these characteristics are influenced by conditions of environment. In order to do this, they compared individuals who had been brought up together, but who differed in genetic constitution, that is, fraternal twins, with identical twins in similar environments, and followed this by a comparison of individuals who were genetically similar, that is, identical twins, but who had been subjected to different environments. The results of the former study showed that in the traits measured, that is, physical dimensions and intelligence, there was a higher correlation between identical and fraternal twins[9], leading to the assumption that genetic constitution is a large factor in these characteristics. Identical twins become neither more nor less alike as they grow older, but with age fraternal twins differ often in mental traits. It has been mentioned before that one member of a pair of identical twins may be born slightly inferior to the other; this initial difference may produce habitual difference—for example, it may be usual for one twin to take the lead in social intercourse. By a simple comparison of the differences in correlation between the two types of twins it was discovered that physical characteristics are least affected by environment, which has most influence on educational achievement and personality.

It was, at first, difficult to obtain suitable subjects for experiments with separated identical twins, since each of the pairs had to have been separated in infancy, and have been separated for a number of years, for the study to have any true value. Finally, the authors were able to publish reports on the cases of ten pairs of twins who had been separated in infancy, ranging from a few weeks to eighteen months old, and had been brought up in different environments for at least ten years. Small differences in environment were found to have little effect, as there were only negligible differences between the twins who had been brought up separately, but in somewhat similar environments. Whenever educational experience had differed to a marked extent, the twin with the greater amount of educational experience had a distinctly

higher score on all ability and scholastic achievement tests. Where there was no or little difference in education, the scores of the separated twins tended to be as similar as those of identical twins reared together. For example, in one case, where one twin ceased her education at an early age, while the other went on to higher education and ultimately became a teacher, there was a difference of twenty-four points in intelligence quotient, in favour of the latter[10]. In another case, in which one twin had been educated at a village school, while the other had been educated at a modern school in a large city, there was a thirty-four months difference in mental age[11].

To digress from this specific study for one moment: a suggestion has been put forward by two Americans that an endowed school should be established in New York for identical twin pupils, staffed by identical twin teachers. In each grade there should be two classes, each containing one of a pair of twins, and each class should be taught by one of a pair of twin teachers. In this way, valuable work could be done in determining the best ways of teaching children. For example, one class could be taught French grammar, with no conversation, while the other could concentrate on speaking French ignoring any emphasis on grammar. Possessing the same genetic constitutions, the members of the two classes would have the same mental endowments, and therefore the difference in the ultimate result would demonstrate the value of one method as opposed to the other.

To return to the study of separated twins, the investigators state that the measurable difference in separated twins attributable to environment is, generally, equal to the sum difference in these cases plus an undetermined amount corresponding to that portion of the difference in unseparated cases attributable to environment. In weight and educational achievements, the separated twins were as different as average fraternal twins, but very similar in other traits. It can be seen that these two characteristics can be explained by the influence of environment. A marked difference in personality was found to be coupled with a marked difference in environment. For example, of one pair it was said: "These brothers, although brought up in widely different circumstances, are similar in manner and the measurable features of behaviour. However, their conduct, from the point of view of direction and social significance, differs widely. We might expect them to act with equal vigour, decision and persistence, but one to a socially constructive, and the other to a socially destructive end."

The following conclusions were drawn from this study. Every trait or character should be studied separately, for each involves different shares of hereditary and environmental factors. Physical characteristics are, in general, more influenced by heredity than mental traits; but the influence of heredity on mental ability is greater than on educational achievement.

A few years ago, Johannes Lange made a study of twins with the view of discovering whether or not the tendency towards criminal behaviour is predetermined[12]. He studied the case-histories of thirty pairs of twins, thirteen monozygotic and seventeen dizygotic, of which one or both had criminal records. Of the thirteen identical pairs, in ten cases both members had been convicted of crime—and in two of the other cases one member had suffered previously from a head injury, which may very possibly have accounted for the difference in behaviour. Of the seventeen pairs of fraternal twins there were only two cases in which both members were convicted criminals. The environmental factors were similar for fraternal and identical twins, but while there was extensive concordance in crime among the latter, there was little among the former. This was shown in the case of one pair of identical twins, both of whom were professional thieves and burglars, although they lived apart, and had had little contact with one another since youth. In his use of the twin method of study, Lange started with the assumption that if the hereditary make-up had no importance, then a comparison between identical and fraternal twins would show little difference; and lack of agreement between twins with identical heredity would enable the investigator to estimate the importance of environmental incentives to crime; and if twins with a different heredity showed closer agreement than other sibs, then environmental influences were important. Lange discovered that so far as crime is concerned, identical twins, on the whole, act in a definitely similar manner, while fraternal twins behave quite differently. Therefore, so far as the causes of crime are concerned, innate tendencies play a preponderant part, and similarity of environment does not entail similarity of behaviour on the part of fraternal twins. Heredity has a role of paramount importance; as well as exhibiting the same criminal tendencies, identical twins were found, in most cases, to follow the same patterns of behaviour in court and in prison. In one case, although in separate prisons and at different times, both twins were exceedingly troublesome and quarrelsome while undergoing sentence, showing strong paranoic tendencies. In identical twins, differences in criminal record were, for the most part, traceable to physical injuries. Social factors and those of experience can be relegated to a minor place in influence, but this does not mean that they can be discounted. Environmental factors are important to the criminal because of his suggestibility, but it is interesting to note, since environment itself depends to a very considerable extent on the type of individual concerned, that in no case did either or both members of the thirteen pairs of monozygotic twins move permanently into a different social class, whereas this did occur among the dizygotic twins, where, in one case, one twin was a Government official, while the other was a common vagrant and professional thief. We may, therefore, conclude that an underlying cause of habitual criminality is the inheritance of a predisposition to anti-social behaviour—certain hereditary dispositions are almost inevitably fated to express themselves in some form of criminal behaviour.

The results of the work of Prof. Kranz in the same sphere of research support Lange's heredity theory. The criminal records of the thirty pairs of identical twins, whom he studied, showed great concordance, while those of the forty-three pairs of fraternal twins showed concordance generally only in the fact that both twins had been convicted, not necessarily of the same crime or for the same number of times. Kranz considered that mere conviction record was not enough, since one twin may easily escape conviction. He surmounted this difficulty by a method of personal interview, which often revealed that in discordant identical twins the career of the non-convicted twin was such as to suggest a criminalistic character essentially similar to that of his convicted co-twin. He divided criminals into two types: the biologically inferior, who were chronic offenders, and

those who had been led to one mis-step by unfortunate environmental circumstances: and he stated further that only the fate of the former type was predetermined by heredity.

From the results of these various studies of twins, which have helped and are helping to solve the problem of what Galton called Nature versus nurture, it can be seen that no simple answer can be given. The functions and values of heredity and environment are completely interwoven, and are not, as has been asserted by some people, intrinsically antagonistic. They vary in relative importance in regard to specific and general traits; but it can be said that, while both heredity and environment contribute to intelligence and the physical qualities of an individual, the contribution of heredity is several times that of environment. Education and training vary in relative importance in relation to the hereditary type with which they are dealing; the more intelligent the individual, the more potent the educational and general environmental influence. Environment tends to become more important as heredity becomes higher and more complicated.

Plato said that "Environment is most effective when it operates on complex nature". The forms of behaviour which constitute the adjustment of the individual to his environment at a complex level of performance are affected both by the original nature of the individual and by his environment and are not the sole product of either.

[1] Newman, H. H., Freeman, F. N., and Holzinger, K. J., "Twins: a Study of Heredity and Environment" (University of Chicago Press, 1936), 36.

[2] Galton, F., "Inquiries into Human Faculty and its Development" (New York: Macmillan and Co., 1883), 216–242.

[3] Thorndike, E. J., "Measurement of Twins". Archives of Philosophy, Psychology and Scientific Methods, No. 1 (September 1905), 1–64.

[4] Merriman, C., "The Intellectual Resemblance of Twins", Psychological Monographs, Vol. 33, No. 5 (Princeton, N.J.: Psychological Review Co., 1924).

[5] Wingfield, A. H., "Twins and Orphans: the Inheritance of Intelligence" (London and Toronto: J. M. Dent and Sons, Ltd., 1928).

[6] Hogben, L., "Genetic Principles in Medicine and Social Science" (London: Williams and Norgate, 1931).

[7] Rosanoff, A. J., Handy, L. M., Plesset, I. R., and Brush, S., "The Etiology of so-called Schizophrenic Psychoses". *Amer. J. Psychiatry*, 140, 247 (September 1934), 247–286.

[8] See ref. 1.

[9] Ref. 1, p. 93.

[10] Ref. 1, p. 250.

[11] Ref. 1, p. 191.

[12] Lange, J., "Crime as Destiny", translated by Charlotte Haldane (1931).

OBITUARIES

Sir James Morton

SIR JAMES MORTON, who died at the age of seventy-six at Dalton Hall, Carlisle, on August 22, represented in his own person the happy combination of dye-user and dye-maker that has played so large a part in the renaissance of the dyestuffs industry in Great Britain since 1914.

Sir James was the second son of the late Mr. Alexander Morton of Gowan Bank, Darvel, Ayrshire, and was educated at the village school of Darvel and at Ayr Academy. He became the chairman of Morton Sundour Fabrics, Ltd., Carlisle, and the Standfast Dyers and Printers, Ltd., Lancaster, and a delegate director of the Dyestuffs Group of Imperial Chemical Industries, Ltd.

His attention was first directed to the problem of fabrics fast to light when he went to Carlisle in 1920 with a branch of the Ayrshire works which had been manufacturing furnishing fabrics for some thirty or forty years. The story of the development which led to the founding of the Morton Sundour Fabrics Ltd., from his first experimental exposures conducted in his greenhouse at Penrith at that time, has been graphically told by him in his monograph "Fast Dyeing and Dyes". However slight its claims as a serious historical study, this brochure illustrates to the full the energy, enthusiasm and determination which were such important factors in his success and for which he will long be remembered. His exposures at Penrith and his continental journeys led him ultimately to a range of colours which on certain types of fabrics could be guaranteed against fading from sunlight or ordinary washing. This position was reached in the summer of 1904, and in the autumn of that year guaranteed goods were first announced and sold by Messrs. Liberty in London, for which the trade mark 'Sundour' was afterwards invented. A chemical side to the business for these new developments in dyeing was then started at Carlisle, and by 1914 the Sundour factory had become the largest side of the business.

Sir James' continued interest in the dyeing side of the business is shown by a number of patents he took out in the post-war years, but the cessation of supplies of fast vat dyes, particularly of the indanthrene colours, at the outbreak of war in 1914, led him to take up the manufacture of these dyes himself. He thought that by manufacturing a blue and a yellow, by reverting to some of the dyes used in his first fast dyes, it would be possible to maintain a limited range of Sundour goods. He succeeded in tracing the synthesis of indanthrene blue and yellow far enough to find that both were derived from 2-aminoanthraquinone, which is itself obtained from sodium anthraquinone-2-sulphonate or the silver salt, an intermediate product in the manufacture of alizarin. The determination with which he pursued this objective, overcoming not merely the chemical difficulties of the syntheses but also those presented by plant and raw materials, in the course of which he founded Solway Dyes, Ltd., and later Scottish Dyes, Ltd., was largely responsible for the award to him in 1929 of the Faraday Centennial Medal on the recommendation of the Royal Society, the Royal Society of Arts and the Royal Institution "for signal service rendered to chemical science and industry in this country by developing and extending manufacture of anthracene dyes and more recently by extending their application to silk and wool". In 1929 he was also awarded the Medal of the Royal Society of Arts for his lecture on "Fast Dyeing and Dyes" already mentioned. This and his address on dyes and textiles in Britain (1930) given at the British Association meeting at Bristol in September of that year, like his monograph "To Young Weavers", find a fitting place in the literature of the dyestuffs industry.

Morton was knighted in June 1936 for his services to the dye and colour industries. He was a member of the Dyestuffs Industry Development Committee during 1921–34 and of the Committee on New Industrial Development, 1931–32. He was awarded the honorary degree of LL.D. by the University of St. Andrews in 1930 and was a fellow of the Royal Society of Edinburgh as well as an associate of the Manchester College of Technology.

He took a close interest in social welfare work connected with his Company, and in starting the branch at Carlisle bought Murrell Hill House and its grounds as a place of recreation for his work-people. He took a close interest in the Territorial Army and in the earlier Volunteers, and during the War of 1914–18 was actively concerned in the organization and supervision of munitions-making in the Carlisle area. He had made a close study of native textiles of many countries, of which he had a valuable private collection, and was proud of the fact that he was himself a weaver and a master of that ancient craft. R. BRIGHTMAN.

Mrs. Arthur Strong, C.B.E.

MANY visitors to Rome, as well as colleagues and friends in Great Britain, will miss the wide learning, generous disposal of it, and impressive presence of the former assistant director of the British School of Archæology in Rome, Mrs. Arthur Strong, whose death in Rome on September 16 has been reported. Eugénie Sellers was brought up in France, and obtained honours in the Classical Tripos at Cambridge, from Girton College. In the intervals of travel in Germany, Italy and Greece, she gave university extension lectures on Greek sculpture, and conducted classes in the British Museum. In 1892 she published an excellent translation of Schuchhardt's "Schliemann's Excavations" brought up to date by an epilogue from Walter Leaf. Coming under the influence of Furtwängler, she translated also his "Meisterwerke der griechischen Plastik" (1895), a more ambitious and difficult task; and with her friend, Miss Jex Blake, she published a translation and useful commentary on Pliny's chapters on ancient art (1896). Her marriage in 1897 to the orientalist, S. Arthur Strong, librarian of the House of Lords, gave her access to the great British sculpture galleries, and on his early death in 1904 she succeeded him as librarian of Chatsworth and made valuable use of the collections there, especially the gems and the archæological drawings. During these years her tastes and judgment were maturing in a revision of current opinions about the relation of Roman art to Greek. As before, she found congenial utterance first in her translation of Wickhoff's "Roman Art" (1900) but later in her own "Roman Sculpture from Augustus to Constantine" (1908), the main positions in which she restated and illustrated in her chapters on "Roman Art" in the "Cambridge Ancient History".

Mrs. Strong had long been accustomed to spend much time in Rome, and was a valued helper in the early days of the British School of Archæology there. Under the directorship of Henry Stuart Jones (1903–5) the School undertook, as a collaborated task, a "Catalogue of the Sculpture" in the public collections of the city, which she knew so well, and she took an active part in the preparation of it. In 1909, when Thomas Ashby became director, Mrs. Strong was appointed assistant director, and held office until 1925. It was a strong combination, for while both knew Rome and Italy intimately, it was from quite different points of view: both were inspiring teachers and given to hospitality; the School attracted students, and prospered. Unfortunately, the war years 1914–18 broke up the genial society of archæologists; Ashby went to war duty, Mrs. Strong found other use for her abilities. But the chance discovery in 1917 of a subterranean basilica outside the Porta Maggiore gave her in its beautiful relief decoration a new text for her teaching about Roman art, and for her growing appreciation of the symbolic aspect of ancient art in general, expressed, for example, in her lectures and eventual volume on "Apotheosis and After Life" (1916). She had already given Norton Lectures on this subject in American universities (1913).

In due course Mrs. Strong resumed her place at the British School, produced an Italian revision of her "Roman Sculpture" (1923) and delivered Rhind Lectures at Edinburgh on Roman painting (1920).

When the British School was reorganized in 1925, Mrs. Strong retired from active work in it, and in 1928 completed a comprehensive survey of Roman art to the age of Justinian (1928). In 1927 she was made a C.B.E.; and she held a life fellowship at Girton College founded for her by her friends. Still living in Rome, she maintained and extended her wide circle of friends; making most generous use of her learning and practical knowledge of Italy, and in spite of increasing disabilities, continuing her literary activity almost to the end. JOHN L. MYRES.

Mr. H. C. Lawlor

ARCHÆOLOGY in Northern Ireland has lost a prominent figure by the death, on September 4, of Henry Cairnes Lawlor, one of the many amateur workers to whom archæological studies owe so much. This is especially true of Ulster, since unlike the National University of Eire, the Queen's University of Belfast, of which Mr. Lawlor was made an honorary M.A. in 1924, provides no instruction in prehistoric archæology.

While most amateur enthusiasts in this extremely rich province were content to amass large collections of antiquities, Mr. Lawlor showed his interest and made his chief contribution by initiating a series of excavations which were to open up many new lines of research. He was by instinct genealogist and historian rather than prehistorian, and his excavations were conducted before the refinements of modern stratigraphical methods and the significance of minutiæ had penetrated to Ulster, but his was the first cultivation of a field of research which was to blossom notably in the decade ending in 1940. His best-known excavations were those at the pre-Norman monastic site of Nendrum in Strangford Lough, but he examined many other sites in Counties Antrim and Down, ranging in date from the megalithic period to the later Middle Ages. His most original work lay in the elucidation of those most puzzling and widespread of Irish field antiquities, ring-forts and souterrains, and in the study of the earthworks of the early Anglo-Norman period.

Mr. Lawlor published many excavation reports and memoirs, several pamphlets on local history, and a more popular general account of "Ulster: Its Archæology and Antiquities" (1928). These activities were closely linked with the archæological section of the Belfast Natural History and Philosophical Society, which Mr. Lawlor inaugurated. He also took a prominent part in shaping archæological legislation in Northern Ireland and was a leading member of the Ancient Monuments Advisory Council and sectional editor of the "Preliminary Survey of the Ancient Monuments of Northern Ireland" (1940). His interest and support helped to secure the success of the revived *Ulster Journal of Archæology* (1938), on

the editorial board of which he served. He also acted as local secretary for the Society of Antiquaries, and was a member of the Royal Irish Academy.

Born in Ballymena in 1870, Mr. Lawlor came to Belfast and established himself as a linen merchant; and he always took a keen interest in textile history. His character, like his calling, was typical of Ulster. A firm friend to those who knew him well, he was inclined to be stubborn in his archæological opinions and he delighted in controversy. The gap caused by his death will be hard to fill.

E. ESTYN EVANS.

WE regret to announce the following deaths:

Dr. G. T. Bennett, F.R.S., senior fellow and sometime lecturer in mathematics of Emmanuel College, Cambridge, on October 11, aged seventy-five.

Mr. E. H. Clifford, president during 1941-42 of the Institution of Mining and Metallurgy, on October 11, aged sixty-seven.

Mr. A. C. Gardiner, biologist to the Metropolitan Water Board, on August 29.

Prof. W. F. Osgood, emeritus professor of mathematics in Harvard University, on July 22, aged seventy-nine.

Prof. W. M. Tattersall, professor of zoology in University College, Cardiff, on October 5, aged sixty years.

Captain R. D. Williams, officer in charge of clover breeding and other investigations at the Welsh Plant Breeding Station, on October 7, aged fifty-four years.

NEWS and VIEWS

British Drug Houses: Mr. C. A. Hill

MR. CHARLES ALEXANDER HILL has retired from his position as chairman and managing director of the British Drug Houses, Ltd. He has been succeeded by Dr. F. H. Carr, who becomes chairman of the company, and Mr. F. C. Oscar Shaw, who becomes managing director. Mr. Hill represents the third generation of a family of wholesale druggists, his grandfather's firm dating back to the reign of George II; he has done perhaps more than anyone else to establish a sound and progressive fine chemical industry in Great Britain and can look back on a business life of outstanding achievement. He was the moving spirit in an amalgamation of drug firms some thirty-five years ago, thus forming an organization large enough to undertake scientific research which led to the development of the manufacture of fine chemicals in a state of high purity for use in medicine. Hill actively encouraged this development on its scientific side, and among other things introduced during the War of 1914–18 the manufacture of pure reagents for use in analysis, microscopic stains, etc., and went on to supply chemicals of high quality for research purposes, displacing Kahlbaums from the position they had hitherto occupied. For this alone British science owes him a debt of gratitude. Later, the progress in medical science led to the introduction of pure hormones, vitamins and chemotherapeutic products. The production of these by British Drug Houses, Ltd., and the spirit of adventure shown by the firm, have won for it as the leading firm in the fine chemical industry a world-wide reputation.

Some fifty years back, when Mr. Hill was training, the Salters Company founded its first fellowships and scholarships, which have been so fruitful in helping some of our best chemists. The Hill family have a long connexion with the Salters Company, of which three generations have been master, and when the turn of Mr. Hill came at an exceptionally early age he was largely instrumental in forming the Salters Institute of Industrial Chemistry. He has filled many public offices, notably as chairman of the Association of British Chemical Manufacturers during two very critical and difficult years, as president of the Drug Club for four years and of the British Pharmaceutical Conference on three occasions. He can look back on a life of remarkable achievement and great development of his industry largely inspired by his efforts.

Organization of Public Medical Services

READERS who are following the discussions in the medical and general press of the proposals for a Public Medical Service put forward in the Beveridge Report will be interested in Sir Arthur McNalty's Report on the Reform of the Public Health Services, issued by Nuffield College (Oxford University Press, 2*s*. 6*d*.), to the sub-committee on post-war reconstruction of local government of which it was submitted. Its author's service as a former chief medical officer to the Ministry of Health enables him to deal with this complex subject with experience and knowledge of the many factors involved. In Part 1 he discusses the need for a wider outlook in medical teaching and practice, for the education of the public and the medical profession in public health and for reforms in general public health which seem to him desirable. Part 2 discusses the activities of the central health authorities, the organization of which is, the author thinks, needlessly complex and expensive. The frequent substitution of one Minister of Health for another, dictated by political considerations, is contrasted with the non-political organization of the Medical Research Council; a non-political director of a governing National Health Department is considered desirable.

Two illuminating pages reveal who actually does the executive work in the Ministry of Health and how many other Government departments are concerned with national health; the establishment of a co-ordinating interdepartmental committee is suggested. In Part 3 a valuable description is given of the activities of existing health authorities. The general medical practitioner, the specialist, the hospital and its ancillary services, the medical officer of health, the dentist and the research worker are all considered, and defects in the existing system are enumerated. Proposals are then outlined for the administration of general and special health services of Great Britain by local authorities or by combinations of these through regional committees. These proposals include full co-operation by the medical profession and provision of medical services for everybody. Lack of space prevents us from giving more than this skeleton outline of the report. Nuffield College is to be thanked for its decision to issue it as a contribution to the discussion of public health re-organization. The College does not, of course, take any responsibility for the views expressed in it,

pointing out that it is a research institution which has no collective opinions.

Hospital Physicists' Association

AN inaugural meeting of the new Hospital Physicists' Association, held by courtesy at the British Institute of Radiology on September 24, was attended by thirty-seven physicists drawn from hospitals all over Great Britain. The aims of the new Association are to discuss matters arising out of the mutual interests of those engaged in a branch of scientific work which has grown up largely in the last thirty years. Membership is open to physicists attached to hospitals, medical schools, medical or biological research departments. The meeting was followed by visits to the Middlesex, Royal Cancer and Westminster Hospitals on the next day. The afternoon session was devoted to papers. Dr. H. T. Flint spoke on technique with the various radium gram-units; Prof. F. L. Hopwood gave an account of the betatron; Prof. G. Stead discussed teaching for the diplomas and Prof. S. Russ read a paper on the professional equipment of a hospital physicist. Messages of goodwill from the National Radium Commission and the Council of the British Institute of Radiology were read at the meeting. It was agreed that there should be at least three meetings during the year, one of which should be in the provinces. Prof. Russ was elected chairman for the first year, with Dr. Wilson of Westminster Hospital acting as honorary secretary. Prof. Russ reminded his audience that the first full-time appointment as physicist to the Hospital was made thirty years ago. It is likely that to-day between fifty and sixty physicists were engaged in some capacity in hospital or medical research work. A good start was made with the new Association with plenty of evidence of vitality among its members.

Post-War Building Policy

A PAPER, "Housing, Town Planning and Full Employment" by F. J. Osborn, which has been reprinted from *Town and Country Planning*, points out that while the method of compartmental study of housing policy, town and country planning policy and building industry policy is essential owing to the complexity of the subject as a whole, there must also be co-ordination at a high level before major policy decisions are taken. There are, however, ominous signs of different accentuations and of a clash not far ahead. In particular, Mr. Osborn points out that the Minister of Health's housing circular of March 4 is reactionary in its planning implications, and if the local authorities act upon it before a planning policy is announced it will prejudice that policy and preclude its taking the new direction which the Government has been contemplating.

Analysing the building programme to which the Government has been committed by its White Paper of February last, Mr. Osborn considers that the programme is practical in terms of man-power, of labour, of materials, of finance, and suggests that the main difficulty will be the partly, but not wholly, obsolete dwelling. The White Paper programme cannot be carried out without the replacement of nearly all the pre-1914 dwellings in our old towns and villages. Where vacant sites are available nearby, the procedure could be fairly simple. Either the local authority could build or the Government could encourage private enterprise to do so by offering finance on suitable terms. In areas of high concentration this will not be effective, as many old houses will still have a rental value which will persist longer than twenty or twenty-five years. Consequently the total cost after rebuilding will be the present value and the cost of the new buildings which will replace them, and since these costs added together will make the rent of the rebuilt dwellings too high, the obsolete dwellings will still stand.

Mr. Osborn sees only three methods by which this obstacle could be overcome. One of these he rejects —the State to find the money for buying out the existing values of obsolescent dwellings and cancelling them, so that the sites can be cleared for economic re-building at low density. In his view a combination of the other two will be necessary: the employment of a substantial part of the building industry both by the State and by private enterprise under State stimulus in creating entirely new centres of life and work, and planned extensions of existing small towns; and third, to set statutory limit on the life of an old dwelling, a principle which is included in the Uthwatt proposals. He urges the desperate urgency of a planning policy and the necessity of facing squarely the problems of obsolescence of urban buildings and compensation for land values, and creating the machinery for controlling the location of industry and business, and for building new towns and town-extensions to relieve the pressure on space where the bulk of rebuilding has to be done.

Increase in American Longevity

ACCORDING to the April issue of the *Statistical Bulletin*, the organ of the Metropolitan Life Insurance Company of New York, the average length of life of the American people has increased by almost one third since the beginning of the century. In 1941 the average expectation of life at birth was 64·36 years, which was a gain of more than fifteen years since 1901. The record was especially favourable for white females, who in 1941 had attained an average length of life of 68·08, as compared with 63·39 years for white males. Coloured persons showed a greater longevity than the white, though the current longevity among the coloured was still ten years less than for the white. The most substantial gain in longevity occurred in childhood, adolescence and young adult life, the death-rates in 1941 below forty being well under one half those at the beginning of the century. Improvements in mortality have also taken place even after forty. The favourable health situation is also illustrated by the fact that about 60 per cent of the babies now being born will live to 65 as compared with only 40 per cent in 1901. On the whole, health conditions have been very favourable in spite of the growing shortage of civilian medical men, the initiation of restrictions on food consumption, the crowding in centres of war industries and inadequate housing.

Conservation of Wild Life in Great Britain

THE Universities' Federation for Animal Welfare (temporary address, 284 Regent's Park Road, London, N.3) has issued a circular directing attention to the need for co-ordinating the diverse and often conflicting interests concerned with the regulation of wild life, both fauna and flora, in Great Britain. It is suggested that a central "Wild Life Authority" should be set up by statute and charged with the

duty of studying and directing all measures necessary for the control of injurious, and the conservation of desirable, species. Except that the Federation is specially concerned to urge the adoption of humane methods in the destruction of animal pests, its aims seem to differ little from those of several other existing organizations, such as those concerned with national parks, nature reserves, and the like. Further discussion will doubtless emphasize the importance of co-operation rather than competition in this, as in so many other schemes for post-war progress.

Inter-allied Bureau for Educational Reconstruction

AT the sixth meeting of the Conference of Ministers of Education of the Allied Governments held at the offices of the Board of Education on October 5, it was agreed to establish an Inter-Allied Bureau to carry out the practical steps needed to restore educational services in the countries concerned. This Bureau will be the executive body of the Conference. The work to be undertaken by the Bureau includes the purchase and distribution of books and periodicals, the preparation of films and other visual aids and the supply of scientific equipment. These matters are at present being considered by commissions of the Conference. The Bureau was also asked to consider financial needs and methods of contribution by Governments and the establishment of an inter-Allied secretariat.

Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentres of four recent earthquakes. These are in scattered localities but are all in areas where earthquakes are known to be relatively frequent. The first was on July 23, 1943, at 15h. 52.9m. U.T. and occurred near lat. 10·5° S., long. 117·5° E. This is in the Indian Ocean south of the island of Soembawa, approximately between Java and Australia. The next two came from the same epicentre, the second thus being an aftershock of the first, and together showing the tendency of earthquakes to recur from the same epicentre. The first of these was on July 29, at 3h. 02m. 14s. U.T., from an epicentre near lat. 18·9° N., long. 67° W., which is in the Atlantic Ocean between Nares Deep and the island of Puerto Rico and north of the latter. The aftershock occurred on the next day, July 30, at 1h. 02m. 32s. U.T. from the same epicentre in the West Indies. The fourth earthquake occurred on August 10 at 15h. 13·3m. U.T. from an epicentre near lat. 54° N., long. 161° E., which is approximately in the middle of the east coast of the Kamchatka Peninsula and midway between the towns of Ust-Kamchatsk and Petropavlovsk-Kamchatski. The east coast of the Kamchatka Peninsula forms part of the circum-Pacific chain of instability, lying between the Japanese Islands and the Aleutian Islands. The depths of focus of all four earthquakes are considered normal and the interpretations and calculations are tentative. Data were received from seismological observatories in North and South America, Honolulu, New Zealand and Australia.

Comet Oterma (1943*a*)

AN orbit for Comet Oterma, 1943*a*, has been computed, and its eccentricity is only a little more than half that of Pluto. As a result of this small eccentricity, it will be possible to observe the comet easily throughout its orbit. This is the second comet so far discovered which possesses this distinction, the other comet being Schwassmann-Wachmann (1925, ii). The eccentricities are 0·139 for Comet 1943*a* and 0·142 for Comet 1925, ii; but the periods are very different, namely, 8 years and 16·3 years respectively.

The elements of the orbit of Comet Oterma are given below, but as it is at a considerable distance from the sun and the earth, it is not an easy object except for moderate-sized telescopes.

T	1942 Oct. 18. 1040 U.T.	
ω	5° 00′	1943·0
Ω	154 51	
i	3 58	
q	3·44	
e	0·1391352	
P	8·00 years.	

Nova Aquilæ

A TELEGRAM from Copenhagen announces that this nova attained magnitude 7 at the outburst between April 13 and May 2. Its position, referred to the equinox of 1855, is R.A. 19h. 45·5m., Dec. 8° 06′ N. It is a little brighter than magnitude 12 at present.

Announcements

MR. J. BENSTEAD, general secretary of the National Union of Railwaymen, and Mr. E. Thornton, secretary of the United Textile Factory Workers Association and secretary of the Rochdale Weavers' Association, have been appointed members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. Sir John Greenly retired from the Council on completion of his term of office on September 30.

THE College of Physicians of Philadelphia has awarded the Alvarenza Prize to Dr. Ernest Carroll Faust, professor of medical parasitology and acting head of the Department of Tropical Medicine, Tulane University, for his "outstanding contributions to our knowledge of parasitology and tropical medicine".

THE centenary meeting of the Royal Anthropological Institute will be held on October 30. Prof. J. H. Hutton, president of the Institute, will preside, and addresses will be delivered by Sir John Myres on the work of the Institute, and by Lord Hailey on "The Role of Anthropology in Colonial Development" during the morning. The afternoon meeting will take the form of a symposium on "The Future of Anthropology", in which Dr. G. M. Morant will speak on physical anthropology, Prof. V. G. Childe on archæology, Mr. R. U. Sayce on material culture and Prof. R. Firth on social anthropology. The morning meetings will be at the rooms of the Royal Society and the afternoon meetings at the Institute.

THE Nutrition Society has arranged a whole-day conference on "Post-war Nutritional Relief", at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, on November 6. The chair will be taken by Lord Horder and papers will be read by Prof. J. R. Marrack ("Past Experience and Present Position"), Dr. J. Hammond ("Problems of Production in Relation to Post-war Nutritional Relief"), Miss E. M. M. Hume ("Opportunities for Nutritional Research in the Work of Relief") and others. Details of this meeting can be obtained from the hon. secretary, Dr. Leslie J. Harris, Nutritional Laboratory, Milton Road, Cambridge.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Barometer Effect of Penetrating Cosmic-Ray Showers

DURING the past sixteen months we have recorded penetrating cosmic ray showers and barometric pressure. As it was not the main object of the experiment to correlate pressure and penetrating shower intensity, the disposition of the counter arrangement was changed frequently. Altogether two different counter arrangements with fourteen different dispositions of absorbers were used for various lengths of time. One of the arrangements has been described previously[1].

Correlation between barometer and counting-rate was determined in the usual way for each of the separate arrangements. The barometer coefficients obtained for the individual sets of readings were rather uncertain, because of the large statistical fluctuations which were to be expected in consequence of the small counting-rates usual for penetrating showers.

The weighted mean of the fourteen single barometer coefficients appears, however, significant. It was found to be

$$B = -11{\cdot}7 \pm 2{\cdot}7 \text{ per cent per cm. mercury.}$$

The stated error is the *standard error* of B.

The value of B was computed from 270 single readings covering 8,220 hours during which 4,363 coincidences were recorded. The root mean square variation of the barometer during this period was found to be $\pm$ 0·87 cm. mercury.

The fluctuations around the average values of the individual values corrected for the barometer were found to be statistical. Thus there is no indication of large variations of the intensity due to causes other than changing pressure.

The barometer coefficient B is very large and is of the same order as that found by Cosyns[2] and Auger and Daudin[3] for extensive air showers. This confirms the connexion between air showers and penetrating showers.

The large value of the barometer coefficient is, however, surprising in view of the small absorption of penetrating showers in lead. According to our previous measurements, 30 cm. of lead absorbs only about 20 per cent of the observed shower intensity. This difficulty might be removed by assuming that the absorption of penetrating showers is much greater in air than in lead. Such an assumption appears unlikely, as the penetrating showers seem to consist mainly of mesons, and the absorption of mesons is proportional to mass. The decay of mesons which gives rise to absorption anomalies would give rise to a temperature effect rather than a barometer effect.

An alternative explanation of the large barometer coefficient is that the change of intensity of the penetrating showers with barometric pressure is due not to the absorption of the penetrating showers themselves in air but to the absorption of the primaries which give rise to penetrating showers.

Consider those primaries which at a certain air pressure can just reach the top of a lead absorber placed above the counter arrangement. If 1 cm. more of lead is placed above the apparatus, these primaries will be absorbed in the additional lead. But while absorbed, these primaries will give rise to penetrating showers which will be recorded. On the other hand, if instead of the additional lead absorber the air pressure increases by a corresponding amount, the primaries which would have just reached the top of the absorber will now be absorbed about 100 m. above the arrangement. The penetrating showers which are produced will reach the apparatus too diffused to give rise to coincidences. Thus the barometer effect is a measure of the rate of absorption of the primaries.

This point will be dealt with in detail in another paper.

L. JÁNOSSY.
G. D. ROCHESTER.

Physical Laboratories,
University of Manchester.
Sept. 15.

[1] Jánossy and Rochester, NATURE, 150, 633 (1942); *Proc. Roy. Soc.*, in the press.
[2] Cosyns, NATURE, 145, 668 (1940).
[3] Auger and Daudin, *Phys. Rev.*, 61, 91 (1942).

Boiling Point and Viscosity of Gases

RECENT experimental studies[1] on the compressibility of liquids and liquid-mixtures indicated the existence of a connexion between the compressibility and viscosity. The usual equations representing viscosity – temperature relation of liquids do not, in any form, contain the compressibility function. After trial, it was observed that the viscosity of liquids could be well represented by an equation of the form:

$$\eta = AT^{1/2}e^{B/\beta}, \qquad (1)$$

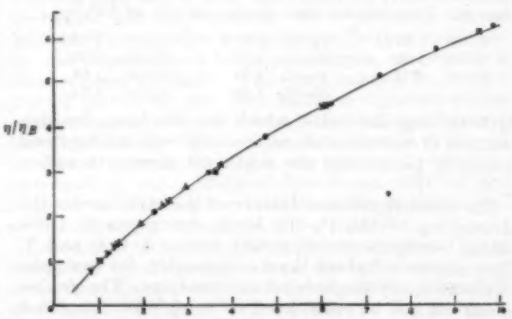
where A and B are constants, and β is the adiabatic compressibility. β, at any temperature, was calculated from the supersonic velocity and the density of the liquid for that temperature.

I was led, further, to consider the question of the viscosity of gases, and from considerations of interaction energy at collision, the following simple formula was obtained, giving the viscosity η at the temperature T:

$$\eta = AT^{1/2} \exp. -(T_B/T)^{1/2}, \qquad (2)$$

$$\text{or } \eta/\eta_B = xe^{(1-1/x)}; \quad x = (T/T_B)^{1/2}, \qquad (3)$$

where T_B is the boiling-point temperature and η_B the viscosity of the gas at that temperature. The relationship was tried and found to hold good for air, argon, hydrogen, nitrogen, oxygen, carbon monoxide



GRAPH SHOWING THE RELATION BETWEEN η/η_B AND T/T_B FOR GAS AND VAPOURS. THE EXPERIMENTAL POINTS REFER TO: AIR ●, ARGON ×, HYDROGEN □, CARBON DIOXIDE △ AND BENZENE ▽.

and carbon dioxide, as well as for vapours like benzene, carbon disulphide, chloroform, carbon tetrachloride, etc., throughout the range of temperature where viscosity measurements are available.

The accompanying curve represents η/η_B plotted against T/T_B as given by equation (3). It will be noticed that the observed points for air, argon, hydrogen, carbon dioxide and benzene all fall on this 'universal curve'. The fit is equally good in the case of other gases and vapours. The formula holds for ordinary range of pressures. Since the boiling point depends on pressure, equation (2) indicates the dependence of the viscosity of a gas on pressure. It may be noted, however, that for pressure changes which are not large, variation in the boiling point and the resulting variation of viscosity would be scarcely observable. A change in the indicated direction is, however, to be found in the experimental results of Kundt and Warburg when the pressure change is not very large.

The detailed account of this work is being published elsewhere.

A. Dutta.

Physics Department,
University of Delhi,
Delhi.
May 10.

[1] Parshad, R., *Indian J. Phys.*, **15**, 223 (1941).

Structure of Geranylamine Hydrochloride

The ambiguity in the interpretation of fibre diagrams makes it doubtful whether satisfactory solutions for the crystal structures of rubber and the gutta-percha isomers will be possible until a more detailed knowledge of the stereochemistry of the polyisoprene system is available. Accordingly a complete crystal structure analysis has been made on the simple di-isoprene derivative, geranylamine hydrochloride,

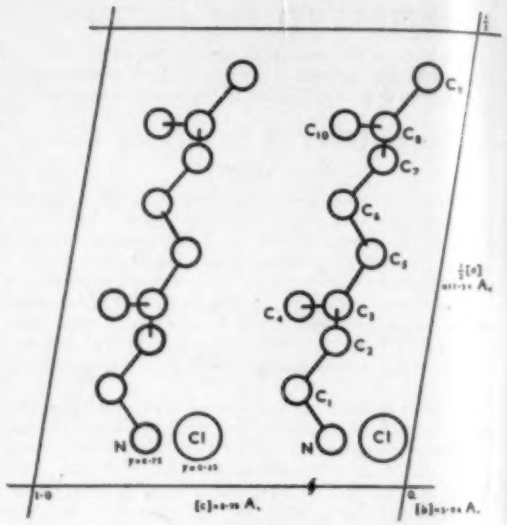
$CH_3.C.(CH_3):CH.CH_2.CH_2.C.(CH_3):CH.CH_2.NH_2.HCl$.

From the experimental data of 1,060 observed reflexion intensities, it has been possible by extensive trial and error calculations followed by three-dimensional Fourier syntheses to establish the parameters for each atom (excluding hydrogen) to an accuracy of about $\pm 0{\cdot}03$ A. The space group is $P2_1/c$, and a diagram of the two glide-related molecules projected on to half the basal plane of the monoclinic cell is shown in the accompanying illustration. The interatomic distances are as follows:

Cl—N	3·23 A.	C_5—C_6	1·31 A.	C_9—C_7	1·52 A.
N—C_1	1·49	C_7—C_8	1·53	C_7—C_{10}	1·31
C_1—C_2	1·54	C_8—C_9	1·51	C_3—C_2	1·53
		C_8—C_4	1·43	C_4—C_{10}	1·54

In both isoprene units, which are identical, the disposition of valencies about the ethylenic double bond is strictly planar and the angles are normal to within $\pm 5°$.

The most significant feature of the structure is the shortening of the C_8—C_9 bond, accompanied by a planar configuration of carbon atoms 3, 5, 6 and 7. This implies a hybrid bond comparable, for example, to the formally single bond in butadiene. The double bonds cannot be considered as completely insulated and some degree of triene conjugation must be envisaged, —C=C—C⋯C—C=C—. Since it is not apparent how the saturated quaternary ammonium pole can be solely responsible for this molecular modification by creating appropriate canonical states, the high electrostatic charge of the N+ must be considered as merely enhancing an effect inherent in the hydrocarbon system. After inductive transmission to the nearer double bond, electron attraction farther along the chain will only be appreciable if it can be relayed by a tautomeric (mesomeric) displacement. Precisely such a mechanism is provided by invoking and developing the incipient conjugation previously suggested[1] as a normal feature of 1 : 5 diene systems by virtue of hyperconjugation involving the α-methylenic C—H bonds.



The details of the complete X-ray analysis will be published elsewhere, together with a discussion of its bearing upon the problems of the natural polyisoprene structures.

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[1] Bateman, L., *Trans. Faraday Soc.*, **38**, 367 (1942).

A New Technique for the Ultimate Microanalysis of Organic Compounds

Under this title, Ronald Belcher and Cyril E. Spooner[1] have described an apparatus for the combustion of organic compounds, consisting of a combustion tube which is not filled with any contact material. The authors refer to their previous publication of a similar macro-method[2], and state that they "originated this unpacked tube technique for the ultimate analysis of Coal", and further say that "so far as we are aware this was the first use of an unpacked tube for this purpose, and we have now adapted it to the micro-scale".

In view of these claims may I be allowed to state that neither combustion analysis without contact material nor its adaptation to the micro-scale are new. In fact, this kind of technique has been repeatedly described by a number of authors from 1864 up to the present time, namely, by C. N. Warren[3],

W. G. Mixter[4], A. Sauer[5], Marek[6], W. Grote and E. Krekeler[7], and A. Schöberl[8]. The latter describes a micro-version. As a safeguard against explosion, C. N. Warren fills his combustion tube with asbestos, while Grote, Krekeler and Schöberl enclose the heated area within two sintered plates for the same reason. These precautions do not, however, alter the fact that contact materials are not used. One further variant by H. ter Meulen and J. Heslinga[9] must be mentioned in this connexion. These analysts recommend the use of some quartz splinters in front of an unpacked heated area.

F. B. STRAUSS.

Dyson Perrins Laboratory,
The University, Oxford.
Aug. 28.

[1] Belcher, R., and Spooner, C. E., *J. Chem. Soc.*, 313 (1943).
[2] Belcher, R., and Spooner, C. E., *Fuel*, **20**, 130 (1941).
[3] Warren, C. N., *Z. Anal. Chem.*, **3**, 272 (1864).
[4] Mixter, W. G., *Amer. J. Sci.*, (3), **4**, 90 (1872).
[5] Sauer, A., *Z. Anal. Chem.*, **12**, 22, 178 (1873).
[6] Marek, *J. prak. Chem.*, (2), **84**, 713 (1911).
[7] Grote, W., and Krekeler, H., *Angewandte Chem.*, **46**, 106 (1933).
[8] Schöberl, A., *Angewandte Chem.*, **50**, 334 (1937).
[9] ter Meulen, H., and Heslinga, J., "Neue Methoden der Organisch-Chemischen Analyse", Leipzig, 37 (1927).

Change of Symmetry of Basic Beryllium Acetate

Preston and Trotter[1] have described a change of symmetry with temperature in the Laue photographs of basic beryllium acetate, $Be_4O(CH_3COO)_6$. This change of symmetry, according to Preston and Trotter, is a reversible one and occurs between 30° and 50° C. At the higher temperature the crystal class possesses three-fold axes with parallel mirror-planes, whereas at the lower temperature only the three-fold axes are present. Preston and Trotter suggest that the increase in symmetry is due to the setting in of molecular vibration of the acetate groups.

We have taken single-crystal photographs of this substance at temperatures between 15° and 80°, using a special Weissenberg camera. These photographs show the change of symmetry very beautifully. Below 25° a spot ($hk0$) has in general a different intensity of reflexion from ($\bar{h}k0$). As the temperature is raised above 25°, however, a change begins which becomes complete at 40° whereby the ($hk0$) and ($\bar{h}k0$) reflexions become equal in intensity. The change is especially rapid between 37° and 40°. As found by Preston and Trotter, the change appears to be completely reversible with no hysteresis.

The Weissenberg photographs give the complete set of ($hk0$) intensities, and permit the changes in atomic parameters to be followed by Fourier synthesis. The signs of the F values are obtainable from the Pauling and Sherman structure[2]. The results of this work enable the following conclusion to be drawn. As the temperature increases from 25° to 40°, there is a gradual change in the parameters of the carboxyl oxygens from the values ($\bar{0}{\cdot}17$ $\bar{0}{\cdot}06$ $\bar{0}{\cdot}04$) to the values ($\bar{0}{\cdot}17$ $\bar{0}{\cdot}05$ $\bar{0}{\cdot}05$) respectively. All other atomic parameters remain unchanged. The low-temperature values ($\bar{0}{\cdot}17$ $\bar{0}{\cdot}06$ $\bar{0}{\cdot}04$), which correspond closely to the Pauling and Sherman structure, mean that the oxygens are already within 0·23 A. of the (110) planes, which become the mirror planes at 40° C. As the temperature is raised above 25°, there is a gradual displacement of all the carboxyl oxygens until at 40° they lie exactly on the (110) planes.

There is thus no question of the setting in of any abnormal thermal oscillations in this crystal. The effect observed by Preston and Trotter is merely due to a small change in the atomic parameters. The change corresponds to a rotation of the CH_3COO groups about the line joining the two carbon atoms, and is such as to make very little alteration in the distances within the molecule. Some of the inter-molecular distances (van der Waals' bonds) are modified slightly.

This crystal would seem to permit a very accurate determination to be made of the size of the –COOH group, and indeed was used for this purpose by Pauling and Sherman. It is not thought that the results derived in the present work by two-dimensional Fourier synthesis are any more accurate than the result obtained by Pauling and Sherman, who used a small number of general intensities. It is thought, however, that the use of three-dimensional Fourier synthesis using all the available general intensities would enable an extremely good determination to be made.

I am indebted to Mr. T. Sheddan for growing the crystals used in this investigation, and for much help in the X-ray photography.

C. A. BEEVERS.
(Dewar Research Fellow.)

Chemistry Department,
University of Edinburgh.
Sept. 15.

[1] NATURE, **151**, 166 (1943).
[2] *Proc. U.S. Nat. Acad. Sci.*, **20**, 340 (1934).

Apparent Vitamin C in Walnuts

THE remarkably high vitamin C content of walnuts has been mentioned by various workers[1,2]. Recent work[3,4] indicates that foods may contain substances which react with the dye and are estimated as ascorbic acid under the usual titration conditions but are not true vitamin C. This apparent vitamin C has now been found in walnuts. Twenty-one samples of five different species have been examined, and all were found to contain considerable amounts of apparent vitamin C (see accompanying table). The *Juglans regia* samples were collected in Kew, Long Ashton and Berkhamsted. All the other samples came from Kew. The flowers of many trees of Juglans and Carya were destroyed by frosts, which prevented the investigation of a wider range of species. The material available was further restricted by the depredations of grey squirrels, at present a serious pest at Kew. The nuts ranged in weight from 2 gm. to 40 gm., and included different stages of ripening up to those in which the shell had become hard and woody. Thus, apparent vitamin C should be found in walnuts which are pickled or used in jam-making, etc. Mapson[3] has found that 14 per cent of the total vitamin C in some walnuts preserved in syrup was apparent vitamin C.

In our investigation the apparent vitamin C was estimated by Mapson's visual method and by our own visual and potentiometric methods[4] on a number of samples. All three methods showed the presence of the apparent vitamin C and (with certain exceptions to be considered in a later communication) the results by the three methods were in reasonable agreement. The apparent vitamin C was not due to tannin, since the results were not appreciably

Species	No. of samples examined	Total vit. C content mgm. per 100 gm.		Apparent vit. C as per cent of total	
		Range	Mean	Range	Mean
Juglans regia	6	1390—2968	2070	19—50	31
Juglans nigra	7	950—2060	1700	23—51	31
Juglans rupestris	6	1022—1606	1360	5—28	18
Juglans cinerea	1	1250	1250	73	73
Carya ovata var. *pubescens*	1	700	700	12	12

affected by removal of tannin by the method of Mirimanoff and Mori[7]. We confirm Ghergheleżhiu's finding that the husk (fleshy mesocarp) of walnuts in the later stages of the growth of the fruit contains a higher concentration of vitamin C than the shell (endocarp) and the tissues enclosed within it. We have further found that the fully developed kernel contains very little vitamin C. Our finding that the concentration of vitamin C is greatest in the outermost tissue and least in the innermost tissue in walnuts is in agreement with previous findings on the distribution of vitamin C in other mature fruits, for example, oranges, lemons and tangerines[8], tomatoes[9]. The proportion of apparent vitamin C in the total vitamin C is often much higher in the husk than in the central tissues, and this appears to be associated with a higher *p*H.

The table shows that our results for the total vitamin C in walnuts were somewhat higher than those found by Pyke, Melville and Sarson in 1942. For example, our mean of 2,070 for *Juglans regia* is above the range of 1,500–1,800 for their results on this species. This may be due to seasonal variations or to other factors to be explored later. When allowance is made for the apparent vitamin C in our *Juglans regia* samples the mean true vitamin C is about 1,470. This is only slightly lower than the range of 1,500–1,800, and in other seasons the mean true vitamin C in *Juglans regia* might easily fall within this range. Thus our findings agree with those of previous workers in showing walnuts to be a remarkably rich source of vitamin C, but also show that walnuts in general contain considerable amounts of apparent vitamin C, which will need to be taken into account to ensure accurate estimations of their vitamin C value.

We are indebted to the Acting Director of the Royal Botanic Gardens, Kew, for providing samples of nuts, and to Miss Elaine Finnigan for assistance in making the extracts.

Details of this investigation will be published elsewhere.

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Royal Botanic Gardens,
Kew.

FRANK WOKES.
JOAN G. ORGAN.

'Ovaltine' Research Laboratories,
King's Langley, Herts.
Sept. 18.

[1] Ghergheleżhiu, *Bull. App. Bot. Genetics*, Plant Breeding, U.S.S.R., Supp. 84, 2, 206 (1937).
[2] Pyke, Melville and Sarson, NATURE, 150, 267 (1942).
[3] Mapson, NATURE, 152, 13 (1943).
[4] Wokes, Organ, Duncan and Jacoby, NATURE, 152, 14 (1943).
[5] Mapson, unpublished results.
[6] Wokes, Organ, Duncan and Jacoby, unpublished results.
[7] Mirimanoff and Mori, *Schweiz. Apoth. Z.*, 78, 685 (1940).
[8] Bacharach, Cook and Smith, *Biochem. J.*, 28, 1038 (1943).
[9] Wokes and Organ, *Biochem. J.*, 27, 259 (1943).

Vitamin C in Walnuts

WE have recently taken the opportunity of estimating the ascorbic acid and 'total' ascorbic acid (that is, ascorbic acid plus dehydroascorbic acid calculated as ascorbic acid) contents of the epicarps of two varieties of ripe edible walnuts (*Juglans regia*). In each case the endocarp was very hard, the epidermis was beginning to show dark patches and the epicarp was very juicy and possessed an odour similar to that of juglone (5–OH 1 : 4 naphthaquinone). The results are given in the accompanying table.

	Conc. of ascorbic acid (mgm./gm. of tissue)	Conc. of 'total' ascorbic acid, or vitamin C (mgm./gm. of tissue)
1. Variety 'Wilson's Wonder'	3·86	4·04
2. Variety ?	8·75	9·30

The method of estimation used was that described by Lugg[1,2], which makes use of the reduction of the dye 2,6-dichlorphenolindophenol by ascorbic acid, and of reactions with formaldehyde as a means of distinguishing ascorbic acid from a number of extraneous reducing substances.

The metaphosphoric acid extracts contained only small quantities of extraneous reducers, and these were of the type which does not react readily with formaldehyde at *p*H 1·5 and *p*H 3·5. They contributed only 5–10 per cent of the total reducing capacities of the extracts and their contributions were scarcely affected by sulphuretted hydrogen treatment in the estimation of dehydroascorbic acid. Reduced juglone was found to behave substantially as a reducer of this type, and consequently only several per cent of the total reducing capacities of the extracts could be attributed to reduced juglone.

In so far as these extracts may have resembled the extracts examined by Pyke, Melville and Sarson[3], who used green, whole walnuts, we confirm their belief that the great reducing capacities are due almost entirely to the presence of ascorbic acid. Attention should be directed to the fact that we found only small amounts of dehydroascorbic acid in our extracts.

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Commonwealth Council for Scientific and
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University, Adelaide. July 27.

[1] Lugg, NATURE, 150, 577 (1942).
[2] Lugg, *Austral. J. Exp. Biol.*, 20, 273 (1942).
[3] Pyke, Melville and Sarson, NATURE, 150, 267 (1942).

A Precipitin Test for Typhoid Fever

TREATMENT of typhoid fever with the serum from convalescents of this disease is a well-recognized therapeutic procedure. The good results obtained are believed to be due to passive immunization, as in other forms of serum therapy. From the serological analysis of a large number of convalescent typhoid sera it was, however, observed that their antibody content, both of *O* and *Vi* antibodies, was universally poor. On the other hand, in spite of their paucity in antibodies, such sera had proved to be very efficacious therapeutic agents in our hands during the last few years. This experience could not, therefore,

be reconciled with the statements of Felix and his co-workers on the important role of *Vi* antibody, and its antigenic counterpart, in typhoid immunity and infection; in fact, this antibody forms the principal constituent of Felix's therapeutic anti-typhoid serum. Further experiments were, therefore, undertaken which revealed that when a convalescent serum was injected into human beings, as well as laboratory animals, it led to the production of an appreciable amount of *Vi* antibody and that its therapeutic efficacy was directly proportional to the amount of antibody so produced. These observations could only be explained by assuming that the convalescent serum either stimulated the antibody-forming apparatus in some unknown manner or that it contained an antigen responsible for *Vi* antibody formation. It has now been ascertained that the latter explanation is correct and the typho-precipitin reaction reported here is based on the presence of a *Vi* precipitinogen in the sera of typhoid patients both during infection and during convalescence. The qualitative and quantitative determination of this antigen has been found to be of definite significance in the diagnosis, the prognosis and the treatment of typhoid fever.

Five capillary drops of a *pure Vi* serum (titre 250–500) were measured in each one of a row of precipitin tubes with a capillary pipette (56 drops to 1 c.c.). To these were added equally large five drops of a serially diluted serum under test for its *Vi* precipitinogen content. The mixture, after being well shaken, was incubated at 37° C. for one hour. It was then left in the refrigerator overnight and the reading taken after an interval of 20–24 hours. The development of a deposit and not an opalescence was the criterion of a positive test.

No *Vi* precipitating antigen was found to be present in the sera of typhoid patients during the early stage of disease, especially during stadium incrementi. It could, however, be detected towards the end of stadium fastigium and continued to be present in considerable quantities for 2–3 weeks after the temperature had stayed normal. A large number of normal sera examined did not show its presence nor could it be detected in infections other than typhoid fever. A previous history of *T.A.B.* inoculation did not affect the diagnostic value of the test. Any evidence of flocculation was proof positive that the patient was either suffering or had just suffered from typhoid fever, especially in cases where the isolation of the infecting organism had been unsuccessful and the results of other serological reactions only suggestive of typhoid infection.

From the prognostic point of view the presence of this antigen strongly indicated that the patient was getting the better of infection. In cases complicated with toxæmia, hyper or prolonged pyrexia, abdominal or meningeal involvement and those who relapsed, the *Vi* precipitinogen was either found to be absent or present only in traces at irregular intervals. A fair idea could thus be obtained as to where serological interference with convalescent serum was necessary in cases of typhoid fever.

In the absence of any method by which the potency of a therapeutic convalescent typhoid serum could be assessed, the application of the typho-precipitin reaction gave valuable information as to the suitability or otherwise of the serum of a particular convalescent, the period of convalescence at which the most potent serum was available and its dosage in different types of complications.

Since these experiments proved that active rather than passive immunization resulted from this form of serum therapy, convalescent serum was tried as a prophylactic antityphoid measure. No negative phase was observed, the *Vi* antibody forming within a period of 48 hours. There was no rise of temperature and no localized or generalized after-effects. In view of the general experience that *T.A.B.* vaccine inoculation gives rise to very little *Vi* antibody formation, these results can be considered to be encouraging from the immunological point of view.

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July 15.

Demonstration of the *Rh*-Factor in the Blood of a 48-mm. Embryo

Landsteiner and Wiener[1] described a new antigenic factor, *Rh*, present in 85 per cent of human erythrocytes. This factor they detected by means of agglutination reactions with a suitably absorbed serum obtained by immunizing rabbits and later guinea pigs with *Macacus rhesus* cells.

Human sera containing anti-*Rh* agglutinins and mainly obtained from mothers giving birth to children affected by hæmolytic disease may also be used as typing reagents.

These latter are more suitable since in certain cases they are very potent and obtainable in relatively large quantities. Typing of adult cells with such sera gives clear-cut agglutination reactions.

It was found that the blood of a 48-mm. embryo approximately eleven weeks old could readily be typed (see accompanying table). The agglutination reaction between this blood and potent anti-*A* immune rabbit serum* was very weak, and this relative difference between the strength of the reaction with this serum and human anti-*Rh* sera may indicate that the factor *Rh* develops relatively early in fœtal life.

TITRATIONS OF FŒTAL CELLS WITH HUMAN ANTI-*Rh* SERA AT 37° C.

	Serum				
Cells	1	2	3	4	Anti-*A*
Fœtal	1 : 16	1 : 32	1 : 1	Neg.	1 : 1
Adult	1 : 512	1 : 512	1 : 8	1 : 16	1 : 128

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Sept. 11.

* I wish to thank Dr. Langley for preparing the rabbit serum.

[1] Landsteiner, K., and Wiener, A. S., *Proc. Soc. Exp. Biol. and Med.*, **43**, 223 (1940).

Infection of Laboratory Animals with Johne's Disease and Leprosy

ACCORDING to Francis[1], "until recently it was generally accepted that laboratory animals had not been infected with *Myco. lepræ* or with *Myco. johnei*". As regards the latter organism, in 1913 five out of twenty-three rabbits, six out of forty mice and three out of twelve rats were successfully infected[2], the

disease in three of the mice extending from the stomach to the rectum. In some situations even the muscular layer was invaded by the specific micro-organism, although the majority were found in the apices of the villi. The bacteria were grown on F. W. Twort's *Myco. phlei* egg medium or acclimatized to grow on ordinary glycerine-beef broth, although admittedly it would probably have been better to use naturally infected bovine gut. It was easier to infect by injection than by feeding, but by the latter method infection of the mesenteric glands was not at all difficult, although, of course, this does not mean that intestinal disease would have followed had the animals been allowed to survive.

C. C. TWORT.

Portslade Research Laboratories,
South Street, Portslade,
Sussex.

[1] NATURE, 152, 250 (1943).
[2] *Vet. News*, Jan. 24, 1914.

IN the corrected proof of my article, which unfortunately, owing to my absence on leave, did not reach the printers until the article was in press, I had altered the phrase to which Mr. Twort objects to read, "it was generally accepted that laboratory animals could not be infected with *Myco. lepræ* or with *Myco. johnei*". This correction was made in the reprints. In my original paper[1], I gave a summary of Twort's work but also referred to subsequent experiments which had led workers "generally to accept that laboratory animals could not be infected with *Myco. johnei*". Owing to the almost complete failure of the subsequent experiments, it has not been possible to study Johne's disease in laboratory animals. It is hoped that by the use of very young animals this will now be possible.

JOHN FRANCIS.

[1] *J. Comp. Path.*, 53, 140 (1943).

Propagation of Potatoes

IT is interesting in view of the recent correspondence[1,2] on this subject to recall that a century ago the planting of whole tubers was by no means the only method employed for propagating the potato. Louden ("Encyclopaedia of Agriculture", 1844) lists the use of small cuttings, sprouts, shoots, eyes, and buds, as methods of propagation, and in "Encyclopaedia of Gardening" these and other methods are described. The following notes are based on descriptions given in the 1871 edition of "The Encyclopaedia of Gardening", although, so far as can be judged from the preface, they are likely to be identical with descriptions given in the earlier (1834) edition.

Cuttings were made of young stalks or branches, 5–6 in. in length, in May or June and struck in showery weather in the open or under a hand-glass or in pots. Layers were made in June or July when the potato stalks were 1–2 ft. long, and after layering, these shoots, according to Louden, emit roots at every leaf and produce full-grown potatoes the same year. Suckers may be removed in June, with a few roots attached, and planted carefully when, like layers, they will produce a late crop of tubers.

In seasons of scarcity the sprouts generally found on store potatoes in spring may, when carefully planted in loose well-prepared soil, be made to yield a crop. Propagation by portions of tuber is, according to Louden, the only method fit for general use. He writes: "In making the sets or sections reject the extremes or watery end of the tuber as apt to run too much to haulm, and having the eyes small and in a cluster. Reject also the root or dry end as more likely to be tardy in growth and as according to some producing the curl. Then divide the middle of the potato so as to have not more than one good eye in each set. Where the potato scoop (described and figured in 'Encyclopaedia of Agriculture') is used, take care to apply it so that the bud or eye may be in the centre of each set which this instrument produces of a semi-globular form. The larger the portion of tuber left to each eye, so much the greater will be the progress of the young plant. The scoop is only to be used in seasons of scarcity when the portion of tuber saved by it may be used for soups for the poor or for feeding cattle."

L. G. G. WARNE.

Botany Department,
The University,
Manchester. Sept. 29.

[1] Polunin, N., NATURE, 151, 421 (1943).
[2] Bates, G. H., NATURE, 152, 135 (1943).

Future of Technical Colleges

THE attention of the Council of the Association of Technical Institutions has been directed to the letter on the above subject by Dr. H. Lowery.

The Council is much concerned at some of the statements which are made in that letter. These statements give a very inaccurate picture of the work done by the technical colleges at the present time, and it is doubtful whether in the majority of cases they would ever have been true. In those technical colleges where degree courses are undertaken they are certainly not in any way of a makeshift character, and it would be untrue to say that they have grown out of a makeshift system. In many of the larger technical colleges the staff and laboratory equipment compare most favourably with those of the universities, and not only are the numbers of students comparable, but also the results obtained are academically excellent. The numbers of students taking honours degree courses of the University of London in the technical colleges of the country are quite comparable with those in the internal colleges of the University itself, and it must be remembered that the term 'external' has now quite changed in significance, since the technical colleges working for London degrees are inspected by representatives of the universities and only offer degree courses after full approval by the University has been given.

There is much in Dr. Lowery's letter with which we should very heartily concur, but there would appear to be no useful purpose served by deprecating the outstandingly excellent work on the degree side which many technical colleges have undertaken for some time now, and it is particularly unfortunate that in submitting the evidence to support his case, he should have used statements so far from the truth.

H. SCHOFIELD.
(Hon. Secretary.)
H. GARRATT.
(Chairman of the Council.)

Association of Technical Institutions,
Loughborough College.
Oct. 2.

GEOGRAPHICAL DISTRIBUTION OF *Arenaria humifusa* Wahlenb., NEW TO THE FLORA OF SPITSBERGEN

By DR. NICHOLAS POLUNIN
Fielding Herbarium, University of Oxford

OF outstanding interest, and the subject of much controversy, is the tiny boreal caryophyll now generally known as *Arenaria humifusa*. It was described as a species by Wahlenberg[1] so long ago as 1812, but afterwards became more widely known as a supposed sub-species or variety or even mere *forma* of *Arenaria ciliata* or *A. norvegica*—or, latterly in America, as the full species *A. cylindrocarpa* Fernald. In 1935 Prof. Rolf Nordhagen[2], after having gathered together (as he used to say) "a very great material" of it, resurrected the designation *Arenaria humifusa*; this is probably the correct one, material from the two sides of the Atlantic being apparently identical and moreover showing a similar range of variation, for example, in habit and pubescence[3].

But the bulk of Nordhagen's much cited book[2] "Om *Arenaria humifusa* Wg. og dens betydning for utforskningen av Skandinavias eldste floraelement" is concerned, as the title implies, rather with discussions of the distribution and historical-phytogeographical significance of the plant, which had already attained some fame in this connexion through the attention of Prof. M. L. Fernald[4], and has since been thus cited very widely, for example, by Abbe[5], Hultén[6], and others, including Fernald, who recently styled it[7] "the famous relict of northern Europe". The rather attractive and soon popular contention was that with some other plants of 'senescent' or 'conservative' (as opposed to 'aggressive') tendency, colonies of *Arenaria humifusa* had persisted in isolated areas which had been ice-free 'nunataks' throughout at least the latest Pleistocene maximum and had survived there, or at least near, until the present day. Meanwhile, examination of one of these 'refugia' by Abbe[5] having brought forth rather conflicting evidence, Raup[8] and Wynne-Edwards[9] tended among others to be at least reserved in their judgment, the last-named putting forward an alternative hypothesis.

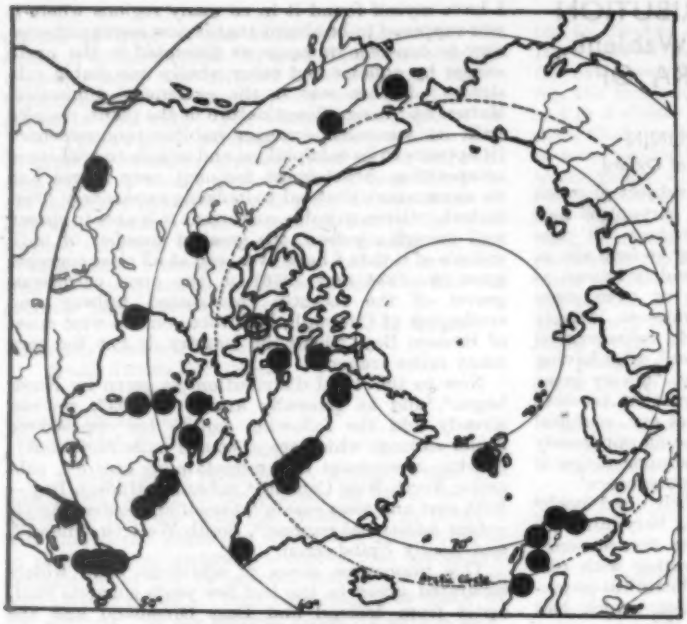
I am not myself prepared at present to enter the controversy, though I would like to see it stimulated to an early conclusion. On one hand I have observed enough plants growing successfully near to, or even on nunataks within, present-day glaciers even in the far north to believe that such 'persistence' is a distinct possibility, while on the other hand I cannot help recalling that substrate and the lack of competition may be of great importance respectively in determining plant populations locally and in aiding ecesis, that migratory birds as well as plants have their own habitat preferences, that a single disseminule carried by any one of all the birds migrating in a millennium (so to speak) "would be sufficient to stock a country or island with any given plant"[10], and finally that "sea ice . . . forms a splendid field for the transport of wind-borne seeds and fragments of plants"[11] particularly of coastal habitats.

Meanwhile, the case of *Arenaria humifusa* may yet present no serious problem, but may help in general clarification: for its actual geographical range is very different from what Nordhagen[2] and others took it to be from the facts to which they had access. Thus I have myself found it in so many regions where it was supposed to be absent that it now seems unnecessary to consider its range as disrupted in the north except by aquatic and other wholly unsuitable substrates. Rather was it the extremely diminutive stature and insignificant nature of the plant, coupled with its somewhat exacting habitat requirements[12] (it appears to be calciphilous and unable to withstand competition, hence most frequent near shores and on mountains), that led to its being extensively overlooked. Given suitable conditions it is able to spread well enough; indeed, the greatest number of individuals of it that I have ever seen at all close together grew (in 1934 and 1936) on the open calcareous gravel of the recently constructed railway and settlement of Churchill, Manitoba, on the west coast of Hudson Bay, where the country is flat for very many miles around.

Now to the 'total distribution' as given by Nordhagen[2], and as generally known in 1935, we can already add the following *regions* (as opposed to minor stations which are of course more numerous): Alaska—west coast and mountainous centre[13], subarctic North-West Canada[14], subarctic Hudson Bay—both east and west coasts[15], Canadian Eastern Arctic—four additional regions[12], South-West Greenland[16], and finally Spitsbergen.

This impressive series of additions from widely separated areas in the last few years suggests that, apart from Iceland and East Greenland and the northern parts of the Canadian Western Arctic, which are quite inadequately explored, and where the species may well occur, it can be considered as generally distributed across arctic and subarctic (climatically delimited) Europe and America right to the extreme west of Alaska. Its distribution to the south may admittedly be somewhat disrupted, but it seems at least as likely that this is bound up with the progressively fewer 'open soil' and otherwise suitable habitats in that direction as that it is dependent upon glacial history, though to be sure we still have to answer the provoking question of how the plants got there. Meanwhile, much support for some 'persistence' seems to be derivable from the study of endemics[4].

The Spitsbergen record of *Arenaria humifusa* is deserving of comment as it has not previously been published; it is the newest and perhaps the most surprising of all. Very recently Mr. A. J. Wilmott and I were revising in the British Museum some material which I had collected in Kongsfjord (Kings Bay, *c.* 79° N. on the west coast of the main island) more than a decade ago and found, in a pile of sheets provisionally labelled "? *A. Rossii*", and which incidentally included several specimens of *Arenaria uliginosa* Schleich. apud Lam. which had only once previously been confirmed from Spitsbergen[17], one which obviously belonged to *A. humifusa* (it was nothing like the locally common *A. ciliata* var. *pseudofrigida*), being practically inseparable in all visible characters from material from Finmark so determined by Prof. Nordhagen and also from material from Newfoundland collected and determined by Prof. Fernald as *A. cylindrocarpa*. Arrived back at Oxford I found among my own unmounted and still not worked up material a duplicate of the same number (152 from the vicinity of Ny-London, a largely limestone district on the north shore of Kongsfjord); apart from the variable characters mentioned above and others which were not always visible, this specimen checked wholly with my Canadian



DISTRIBUTION OF *Arenaria humifusa* WAHLENB.

Eastern Arctic and subarctic material approved by Prof. Fernald and also with my south-west Greenland specimens[16]. Indeed, *A. humifusa* is a highly characteristic little plant that cannot well be mistaken for any other, at least in the Arctic. Its total distribution at present known is indicated on the accompanying map; but it seems safe to conclude that some entirely fresh regions and many new stations will be added in the future, further to warn phytogeographers against *assuming* absence of a species until proper search (which still can scarcely be absolute) has been made. New regions may even include the British Isles, where, especially in the Hebrides and Scottish Highlands, many interesting northern plants have southern 'outposts'.

There remain among doubtful reports three which appear to be supported by specimens: (1) "Lake Mistassini (J. M. Macoun)" upheld by Robinson[18] and Nordhagen[3], and which the former, always a cautious student, probably saw, for he cited "*A. ciliata*. . . . Var. (?) *humifusa*. . . . *A. humifusa* Whlb. . . ." from "Mt. Albert, Gaspe, *Allen, Porter*; Lake Mistassini, *J. M. Macoun*, and what is with scarcely a doubt the same thing at Kicking Horse Lake in the Rocky Mts., *J. Macoun*. (Greenland, N. Europe)". I have strong suspicions that the basis of the report by the younger Macoun[19] of *Stellaria humifusa* Rottb. from Lake Mistassini, where he and A. P. Low collected in 1885, belongs in reality to *Arenaria humifusa*, as the two plants might easily be confused and, moreover, this lake is an inland, freshwater one around the margins of which it would amaze me to find the habitually halophilous *Stellaria humifusa*. Meanwhile, be it noted that confirmation of this station would go a long way towards filling the apparent 'gap' between Hudson Bay and the Newfoundland and Gaspe 'outposts' to the south-east. Next we have (2), the specimen in the British Museum from Sir John Ross's second voyage, cited by Simmons[20] and afterwards by Nordhagen[3] as most likely from Boothia Felix. Although the expedition spent much time in that region, where the plant may indeed be expected to occur, they also visited points in the Holsteinborg district of West Greenland[21] where *Arenaria humifusa*, even if it has not yet been found, probably grows (it is "rather common" not far to the north[22] and also occurs to the south[16]), while on the voyage home they camped on beaches in the limestone region of northern Baffin not very far from Arctic Bay, in the vicinity of which I have found the plant several times on similar calcareous terrain near the sea. As we have no known means of telling whence this specimen from Ross's second voyage came (for unfortunately it lacks any indication as to locality, collector, or even date) it seems wisest to mention it only with a strong query. Finally (3), the report by Schischkin and Knorring probably refers to the well-known station on Fiskerhalvøen[2], even if these authors give it as Karelo-Lapland rather than the 'arctic belt' (see maps and lists at beginning of Komarov's Fl. U.R.S.S. series). Meanwhile, it seems remarkable for a plant elsewhere so widespread that there should be only the one known station in all Russia, the whole of Siberia being apparently excluded from its range, although the plant is known to extend virtually from westernmost Alaska eastwards around the remaining more-than-half of the polar cap.

[1] Wahlenberg, G., "Flora Lapponica" (Berlin, 1812).
[2] Nordhagen, Rolf, *Bergens Museums Arbok*, Naturv. rekke, No. 1 (1935).
[3] Schischkin, B., and Knorring, O., in Komarov, "Flora U.R.S.S.", **6**, 517 (1936).
[4] Fernald, M. L., *Mem. Amer. Acad. Arts and Sciences*, **15**, 230 (1925); *Rhodora*, **28**, 79, 213 (1926), **35**, 205 (1933).
[5] Abbe, Ernst C., *Rhodora*, **38**, 102 (1936).
[6] Hultén, Eric, "Outline of the History of Arctic and Boreal Biota during the Quaternary Period" (Stockholm, 1937).
[7] Fernald, M. L., *Rhodora*, **44**, 114 (1942).
[8] Raup, Hugh M., *Bot. Rev.*, **7**, 147 (1941).
[9] Wynne-Edwards, V. C., *Trans. Roy. Soc. Canada*, Ser. III, **31** (V), 33 (1937); III, **32** (V), 35 (1939); cf. Griggs, R. F., *Bull. Torrey Bot. Club*, **67**, 575 (1940).
[10] Ridley, H. N., "The Dispersal of Plants Throughout the World" (Ashford, Kent, 1930).
[11] Ostenfeld, C. H., *Kgl. Danske Vidensk. Selsk. Biol. Medd.*, VI, 3, 1 (1926).
[12] Polunin, Nicholas, "Botany of the Canadian Eastern Arctic, Pt. 1" (Ottawa: National Museum of Canada, *Bull.* No. 92 (1940)).
[13] Porsild, A. E., *Rhodora*, **41**, 141, 199, 262 (1939).
[14] Raup, Hugh M., *J. Arnold Arb.*, **17**, 180 (1936).
[15] Polunin, Nicholas, Ottawa: National Museum of Canada, *Bull.* (in preparation).
[16] Polunin, Nicholas, *J. Linn. Soc. London*, **52**, 349 (1943); *Proc. Linn. Soc. London*, Session 154, 118 (1943).
[17] Scholander, P. F., *Skr. om Svalbard og Ishavet*, No. 62 (1934).
[18] Robinson, B. L., *Proc. Amer. Acad. Arts and Sciences*, N.S., **21**, 273 (1894).
[19] Macoun, James M., Geol. and Nat. Hist. Survey of Canada, Annual Report (New Series), I, 36D (1886).
[20] Simmons, H. G., Rep. Second Norwegian Arctic Expedition in the "Fram" 1898–1902, No. 2 (1906); *Lunds Univ. Arsskr.*, N.F. Afd. 2, **9**, No. 19 (1913).
[21] Ross, Sir J., "Narrative of a Second Voyage in Search of a North-West Passage, and of a Residence in the Arctic Regions during the Years 1829, 1830, 1831, 1832, 1833" (London, 1835).
[22] Porsild, M. P., *Medd. om Grønland*, **58** (1920).

SENSITIVITY OF THE EAR

THE difficulty in securing accurate values of the minimum stimulus that the ear can detect is great. In the first place there are differences in the hearing mechanisms of various individuals tested. Except for those with some definite hearing defect, these differences largely depend on age; as one grows older the response of the ear becomes less, chiefly at the higher frequencies. Measurements of minimum hearing stimulus thus vary with the age of those being tested. Another difficulty is in measuring the minimum stimulus. According to an article by W. A. Munson (*Bell Lab. Rec.*, 21, No. 10; June 1943) two references have been widely used. One is the rms. pressure of the sound wave at a point in a free sound field where the listener's ear will later be placed. This is the simpler of the two, and is particularly applicable to studies of the usual mode of hearing, that is, without the use of telephone receivers or similar devices. The other is the pressure at the ear-drum. This reference avoids uncertainty as to how the pressure, measured in the air previously to the listening test, would be modified at the ear-drum by the head and ear of the listener, and is particularly useful in studying the mechanism of hearing. It involves great technical difficulties, however, since the space in front of the ear-drum is small and almost inaccessible.

Regardless of which of these two methods is used, the pressure involved is very minute—less than 1/1,000 dyne/sq. cm. A pressure of this order of magnitude distributed over the ear-drum results in a force of the order of only $1/10^9$ oz. As an organ for detecting pressure changes, the ear is thus far more sensitive than our tactile organs, since a touch of this lightness would be imperceptible. Even at the upper limit of hearing, the force is only some thousandths of an ounce. Vibrating pressures greater than this become tactable rather than audible and result in the sensation of pain. Any air wave with an rms. pressure above the threshold value enters our consciousness as sound, and the sound becomes louder the higher the pressure. Since it is the loudness rather than the pressure that we are directly conscious of, some scale for measuring loudness is also desirable.

The results of a large amount of work were summarized some years ago by Fletcher and Munson and it was decided to use the loudness of a 1,000-cycle tone as a reference. This frequency is widely used as a test tone throughout the Bell System, and it has the advantage of being very close to the frequency range for which the ear is most sensitive. Since in general the relationship between the magnitude of a sensory response and its stimulus is logarithmic, it seemed desirable to use a logarithmic scale, and for convenience the loudness-level of a 1,000-cycle tone was arbitrarily taken to be the intensity level. Loudness-level at any other frequency or combination of frequencies is taken to be equal to the intensity-level of a 1,000-cycle tone that sounds equally loud. Although loudness-level is measured on a logarithmic scale, and thus corresponds in magnitude to a decibel scale, the unit is called a phon instead of a decibel to indicate that the thing measured is basically different from power.

At 1,000 cycles the threshold of hearing in a free field is just about at 0 intensity-level, which also justifies making the loudness-level and intensity-level equal by definition at this frequency. At 1,000 cycles, therefore, an increase in intensity-level results in an equal increase in loudness-level. This equality is found not to exist at other frequencies, however.

To the question: How little do we hear? the only safe answer is: it all depends. What we hear is a sequence of periodic pressure changes in the air, but how small the pressure changes may be, given a normal young ear, depends on the rapidity of the changes. The ear is most sensitive when the pressure cycles are occurring at rates between 1,000 and 5,000 times per second, since we can then detect changes of less than a thousandth of a dyne/sq. cm. At both higher and lower frequencies, the sensitivity falls off. The studies that have determined these minimum perceptible pressure changes, and the many others that have established units of measurement and adequate techniques and apparatus, have provided the foundations for the extensive studies of hearing that have been carried on in the Laboratories.

CERAMICS FOR HIGH-FREQUENCY INSULATION

ACCORDING to an article by M. D. Rigterink (*Bell Lab. Rec.*, 21, No. 9; May 1943) electrical porcelains which are satisfactory and useful materials for low-frequency currents have been replaced for high-frequency currents by new ceramic materials which have far smaller power factors. This replacement becomes absolutely essential at elevated temperatures such as are encountered in power vacuum tubes in which the insulator operates almost red hot. The power factor of most ceramics increases very markedly with increase in temperature, this causing more conversion of electrical energy into heat and producing a cumulative effect which may lead to a breakdown in any but the very best materials.

The most widely used of the improved ceramics are the steatites, this term now being applied to all synthetic ceramic materials which are prepared with talc as the principal raw material and which have magnesium metasilicate as the principal crystalline phase. Steatite bodies are prepared from mixtures of 60 per cent or more talc, 30 per cent or less kaolin, and the remainder usually of alkali or alkaline earth oxides or compounds that will decompose to give these fluxing oxides. The formed ware is heated from 1,200 to 1,400° C. on a controlled heating and cooling cycle. During this heat treatment the fluxing oxides combine with part of the magnesia, alumina, and silica given by the talc and the clays to form glasses which in turn dissolve more of these constituents as the temperature rises. In addition to glass formation, chemical reactions take place between the solids and between the solids and liquid glasses; crystallizations also occur as the temperature is lowered, and finally crystalline transformations are produced. These complex changes cause the mixture to shrink and to become the hard, dense material known as a steatite ceramic.

Dielectric properties of the steatite ceramics vary considerably, depending on the amount, kind and proportions of fluxing oxides that are used in their preparation. The alkalis are particularly detrimental, and the alkaline earth oxides appear to be especially beneficial. Other variations are caused by the grinding and mixing of the raw materials, the firing cycles, and the nature and the amount of impurities present. All the steatites have unusually

high transverse, tensile, and compressive strengths, these values frequently being as much as three times as high as the corresponding values for electrical porcelains. They also possess resistance to cold flow, ability to withstand high temperatures, resistance to all common chemical agents except hydrofluoric acid, and low porosities.

Steatites have replaced porcelains for some uses solely because of their greater mechanical strength but more frequently on account of their improved dielectric properties. The useful range of dielectric constant for steatite ceramics varies only from five to eight. Loss of electrical energy in these insulators depends more on the power factor than on the dielectric constant.

Another interesting and important property of these steatite ceramics is that those which have good insulating properties for direct current may not be as satisfactory for alternating current. For example, ceramic bodies with the same direct current resistances were prepared for which the values of tan δ at 100 kc. varied by a factor of more than twenty-five. Thus, where a.c. and d.c. voltages are superimposed the dielectric properties for both have to be considered in comparing different materials.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, October 16

INSTITUTE OF PHYSICS (X-RAY ANALYSIS GROUP) (joint meeting with the MANCHESTER AND DISTRICT BRANCH) (in the Physics Department, The University, Oxford Road, Manchester), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "The Physical Optics of X-Ray Analysis"; Short Papers and Exhibition of Apparatus, etc., relating to Industrial Problems.

ASSOCIATION OF SCIENTIFIC WORKERS (NORTH-WEST AREA) (in the College of Technology, Sackville Street, Manchester).—Sir Robert Watson Watt, F.R.S.: "The Freedoms of Science".*

Sunday, October 17

ASSOCIATION OF SCIENTIFIC WORKERS (NORTH-WEST AREA) (in the University, Liverpool).—Sir Robert Watson Watt, F.R.S.: "The Freedoms of Science".*

Monday, October 18

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Dr. E. C. Willatts: "Physical Names for the Map of Great Britain".

Tuesday, October 19

SOCIETY OF CHEMICAL INDUSTRY (AGRICULTURE GROUP) (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. W. Morley Davies: "Lime in Agriculture".

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—The Rt. Hon. Sir Stafford Cripps, P.C.: "Radio and International Relations".

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Dr. G. W. W. Stevens and Mr. P. C. Smethurst: "High-Resolution Microphotography—Graticules".

Friday, October 22

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. F. C. Lea: Presidential Address.

Friday, October 22—Saturday, October 23

TOWN AND COUNTRY PLANNING ASSOCIATION (at the Royal Empire Society, Northumberland Avenue, London, W.C.2).—Conference on "Country Towns in a National Planning Policy".*

Friday, October 22—Sunday, October 24

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at the Waldorf Hotel, Aldwych, London, W.C.2).—Conference on "Management in Action".

Saturday, October 23

SHEFFIELD METALLURGICAL ASSOCIATION at 2.30 p.m.—Discussion on "The Education and Training of Metallurgists" (to be opened by Dr. Edwin Gregory).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

TEACHER OF MATHEMATICS AND GENERAL SCIENCE for Technical Day School and College—The Chief Education Officer, Education Office, Park Road, West Hartlepool (October 20).

EDUCATIONAL PSYCHOLOGIST (full-time)—The County Medical Officer, Public Health Department, Shire Hall, Nottingham (October 20).

ASSISTANT AGRICULTURAL CHEMIST—The Principal, Agricultural Institute and Experimental Station, Kirton, Boston, Lincs. (October 21).

TEACHER OF PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (October 22).

LECTURER (full-time) IN PHYSICAL AND INORGANIC CHEMISTRY, and a LECTURER (full-time) IN ZOOLOGY, WITH BOTANY OR PHYSIOLOGY—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (October 22).

LECTURER IN MINING—The Clerk to the Governors, Technical College, Infirmary Road, Chesterfield (October 23).

LECTURER IN GENERAL SCIENCE for the Junior Technical College—The Principal, Derby Technical College, Normanton Road, Derby (October 23).

LECTURER IN MATHEMATICS, and an ASSISTANT MASTER to teach SCIENCE and subsidiary MATHEMATICS—The Principal, Kingston Technical College, Kingston, Surrey (October 25).

TEACHER OF ENGINEERING SUBJECTS, and a TEACHER OF GEOGRAPHY—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (October 25).

ASSISTANT TO THE ADVISORY MYCOLOGIST—The Advisory Mycologist, School of Agriculture, Cambridge (October 30).

ENGINEERING GRADUATE (or equivalent qualifications) to teach chiefly Mechanical Subjects—The Principal, County Technical College, Dartford, Kent.

ASSISTANT ENGINEER for the British Guiana Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.767).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institute of Statistics, Oxford. Supplement No. 5, Bulletin Vol. 5, New Plans for International Trade. Pp. 40. (Oxford: Basil Blackwell.) 1s. 6d. net. [219

Royal Institute of Chemistry of Great Britain and Ireland. Lectures on Leather. By Dr. Dorothy Jordan-Lloyd. Pp. 31. (London: Royal Institute of Chemistry.) [219

Hannah Dairy Research Institute. Report for the Two Years ending 31st March 1943. Pp. 20+4 plates. (Kirkhill: Hannah Dairy Research Institute.) [219

Geological Survey of Great Britain. Wartime Pamphlet No. 25: Determination of Tin, with Special Reference to Tin Ores. By C. O. Harvey. Pp. 13. (London: Geological Survey and Museum.) 9d. [219

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Other Countries

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